Effect of Emergence Profile of a Single Implant Restoration on the Health of Peri-Implant Soft Tissue

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EFFECT OF EMERGENCE PROFILE OF A SINGLE IMPLANT RESTORATION ON THE HEALTH OF PERI-IMPLANT SOFT TISSUE

By

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ABSTRACT

EFFECT OF EMERGENCE PROFILE OF A SINGLE IMPLANT RESTORATION ON THE HEALTH OF PERI-IMPLANT SOFT TISSUE

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Purpose: The specific aims of this retrospective study were 1) to compare the emergence angle of a SIC of the mandibular first molar to the emergence angle of the natural contralateral tooth, 2) to evaluate the effect of the emergence angle of SIC on the health of the peri-implant soft tissue and 3) to quantify an acceptable emergence angle among SIC.

Materials and methods: Ten MUSoD patients were included, each patient was examined clinically for Plaque Index (PI), Probing Depth (PD), and Bleeding On Probing (BOP) on their mandibular first molar implant crown and contralateral natural unrestored mandibular first molar tooth. Followed with an intra-oral scan of the mandibular arch using Lava True Definition scanner. The emergence angles of mandibular first molars obtained with the scan were then compared to the gingival indices (PI, PD, BOP).

Results: Four deferent variables were tested: emergence angle, PI, PD, and BOP to compare the relationship and effect of the variables on each other and between implant crowns and contralateral natural teeth. For the angle analysis, mean emergence angle measurements showed lingual angles to be greater than the buccal angles, both on natural teeth and implant crown. It also showed implant crowns mean emergence angles to be greater than contralateral natural crowns. For the evaluation of effect of emergence angle on PI or PD, there were no significant effects. However, emergence angle of ≤ 106 degrees on the mesiobuccal and midbuccal surfaces of implant crowns showed a significant effect on increasing BOP.

Conclusion: Within the limitations of this study, the following conclusions were made: Buccal surfaces of mandibular first molar SICs and contralateral natural teeth were overcontoured in relation to the lingual surfaces. Mandibular first molar SICs were undercontoured in relation to their contralateral natural teeth. There was no correlation between mandibular first molar SICs emergence angles and PI. There was no correlation between mandibular first molar SICs emergence angles and PD. There were two correlations between the overcontoured emergence angle of ≤ 106 degrees emergence angle to BOP on the mesiobuccal and midbuccal surfaces of the mandibular first molar SICs.

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CHAPTER I

INTRODUCTION

Long-term success of a prosthetic reconstruction using osseointegrated dental implants have been well documented (1–5). According to Albrektsson et al., an implant is considered successful if it lost no more than 1mm of alveolar bone height in the first year of function and not more than 0.2mm annually in the subsequent years (6). In addition, the implant should not have any clinical mobility, peri-implant radiolucency, pain, discomfort or infection. Albrektsson's criteria of success were extended by Smith et al. to include an esthetic component to implant restorations. It was suggested that, in order to be considered successful, an implant must also allow placement of an esthetic restoration (7).

Success of an implant restoration, particularly a single implant crown (SIC) depends on several factors namely, treatment planning, quality and quantity of bone at the recipient site, surgical technique, type of restoration and appropriate oral hygiene and follow-up (8). Recently, the long-term survival of osseointegrated implants was also related to the transmucosal tissue and its stability around the implant collar (9).

Phillips et al. stated that an implant restoration needs to be in harmony with the crown form of the adjacent natural teeth as well as with the contralateral natural tooth (10). The color, texture and location of peri-implant soft tissue and, cervical profile of the implant restoration, play a critical role in fabrication of an implant-supported restoration (10,11).

For favorable prognosis, an artificial crown form must approximate natural tooth morphology (12,13). Deviation from natural tooth form may stress the dental tissue beyond the capacity to resist disease. The primary etiological factor for caries and periodontal disease in natural dentition is the presence of microbial plaque adjacent to the gingival tissue (12,14). Plaque retention is prominently seen in the interproximal, lingual, and facial cervical surfaces of the teeth. Therefore, creating an ideal cervical contour of an artificial restoration that does not produce ecological niches for plaque is important for long-term prognosis of the restoration (15).

To be able to fabricate a restoration that supports health of the surrounding soft tissue, the emergence profile of natural tooth must be studied. Croll described the emergence profile of a tooth as the portion of axial tooth contour that extends from the base of the gingival sulcus past the free margin of the gingiva into the oral environment (16). Buccally and lingually the emergence profile extends to the height of contour of the clinical crown and, inter-proximally, the emergence profile extends from the base of the gingival sulcus at the cemento-enamel junction (CEJ) to the contact area (16,17). Natural teeth exhibit straight emergence profiles in the gingival third, with an emergence angle of 15 degrees with the long axis of the tooth. The contact areas are located approximately 4 to 5 mm above the interproximal bone in healthy individuals and the embrasure area is filled with the interdental papilla (18,19).

Over-contoured restorations are probably more detrimental to gingival health than under-contoured restoration as the excessive crown contours act as endemic plaque niches (12,20). Hyperplastic gingival tissue is frequently noted around an under-contoured full coverage restoration. However, under-contoured restorations can be maintained with adequate plaque removal procedures and circular tooth brushing techniques (12,20). When emergence profile of a restoration is over-contoured, especially in the gingival one third, removal of bacterial plaque from the tooth surface contacting the gingival sulcus below the height of contour is often difficult (21).

Ideal emergence profile in a SIC is achieved by precise implant placement in the 3-dimensional space. Utilization of custom abutments for restoration further improves the restoration form. They provide support to the peri-implant tissue and allows for customized placement of the crown margin for a cement retained SIC (22). Gingival margin location of the future restoration serves as a guide to determine the depth of implant placement. Angle of emergence plays an important role in establishing esthetics, and in maintaining stable gingival architecture. For emergence angle to be more than 120 degrees, the depth of the implant placement should be approximately equal to the horizontal distance between the buccal edge of the implant and the height of contour of the SIC. In other words, for every millimeter the implant is placed to the lingual, it should also be placed in an apical direction (23). Ideally, the placement of the implant platform should be established 3 mm below the CEJ of the adjacent teeth to provide the distance required to establish the correct emergence of the restoration (24).

The greater the horizontal distance between the buccal edge of the implant and the SIC contour at the level of the gingival margin, the greater is the likelihood that the emergence angle will approach 90 degrees. The severe angle of emergence would require a ridge-lap to create a coronal tooth form that conforms to the adjacent teeth and mimics its natural counterpart. The ridge-lap contours of an implant restoration results in increased accumulation of plaque which obstructs maintaining adequate oral hygiene around the implant restorations often resulting in inflammation of peri-implant soft tissue, apical migration of the gingiva exposing the implant abutment junction and/ or implant thread exposure (23). Over-contoured restorations usually have greater plaque often leading to gingival degradation and inflammation over time. It has also been shown that more extensive plaque is accumulated on an artificial crown compared to a contralateral unrestored tooth. In a study conducted on natural teeth, it was found that, a 170-degree emergence angle allowed for superior cleaning around the accessible margin compared with a 165 or 140 degrees emergence angle (25).

Radiographically determined bone changes and probing depth (PD) changes are used to estimate stability of sites or progression of disease around natural teeth. These parameters are further utilized for implants and may show considerable results in terms of periodontal stability even though there are still limitations with respect to diagnostic accuracy (26–29). Additionally, parameters like, presence or absence of bleeding on probing (BOP), suppuration and visible plaque, have been applied recently for implant site evaluation during maintenance (30,31), even though BOP might have a limited predictive value for disease progression (32).

CHAPTER II

LITERATURE REVIEW

1. Emergence profile

In 1989, B. M. Croll conducted a study on natural teeth to establish the anatomic norms for emergence profiles at specific sites throughout the dentition for developing a basis for accurate reproduction of clinical dental restorations.

The emergence profile is important for maintaining gingival health, preventing plaque-retaining areas, and enabling maintenance of oral hygiene. Longevity of prostheses may be directly associated with proper coronal contours. This involves combining periodontal and prosthodontic principles during the production of prosthesis. In his observations for natural teeth contours, Croll found that most measured surfaces possessed a straight emergence profile. More specifically, Croll found the lingual surfaces of mandibular posterior teeth have straight emergence profiles from the CEJ to points one half to two thirds of the distance to the occlusal surface. Whereas the emergence profile on the buccal surface of mandibular posterior teeth is one of three straight lines comprising the entire facial profile. Restorations made with these facial contours are natural in appearance (16).

According to Parkinson et al 1976**,** success of dental restorations is achieved by meticulous application of psychologic, mechanical, and biologic factors,

The artificial crown contours are critical to soft tissue health, to minimize iatrogenic dental disease; artificial crown form must approximate the morphology of a natural tooth.

If the contours of the restoration exceed natural curvature, the restoration denies the natural defensive capacity of soft tissues. Parkinson et al concluded, that inadequately contoured restorations; stress the dental tissues beyond their capacity to resist disease, and must be associated to the etiology of dental disease. Microbial plaque present and adjacent to the host's gingival tissues is the most common etiologic factor in the pathogenesis, severity, and prevalence of periodontal disease (33).

Jameson et al in1982 examined the relationship of crown contours and gingival health and concluded; that overcontouring of restorations is probably more unfavorable to the health of the gingiva than undercontouring because, excessive crown contours facilitate endemic plaque niches. The common gingival response to an undercontoured restoration (more in mandibular molars) is hyperplastic tissue. However, this can be less damaging to the health of soft tissues with adequate plaque removal procedures and circular tooth brushing techniques (20).

Parkinson in1976 concluded that crown contour is a mediating factor for plaque accumulation and gingival health at the tissue-restoration interface. More specifically, 60% to 70% of teeth with overcontoured axial buccal surfaces showed gingival degradation and inflammation over time (33).

Sundh et al 2002 evaluated the effect of crowns with different emergence profiles on marginal plaque formation and found that when there was an emergence angle of 170 degrees on an artificial crown, the margin is more accessible to active cleaning than at 165 and or 140 degrees, but the effect of self-cleansing is similar regardless of angle (25).

Neale et al 1994, appropriate emergence profile of an implant-supported restoration is essential for hygiene, gingival health, and appearance(34). A proper emergence profile should be considered in all 3 dimensions to avoid the development of a ‘‘ball on a stick’’ restoration. Emergence profile is directly related to implant placement. The length of the subgingival portion of the restoration is particularly important, because guided gingival growth is ultimately related to the depth of the implant (35).

2- Ideal implant positioning

Ideally, the placement of the implant platform should be established 3 mm below the CEJ of the adjacent teeth to provide the distance required to establish the correct emergence of the restoration out of its “socket”. If this can be established, then a prefabricated abutment may be used to construct the definitive prosthesis. If soft tissue depths exceed 3 mm, then customization may become necessary to follow the existing gingival topography. The need for customized abutment may also be beneficial in more challenging prosthetic situations (36).

3- Gingival indices

The question of whether crowns have an effect upon periodontal tissue condition has been the focus of numerous studies in dental literature and for many years. Specific interest has been paid to the relationship between periodontal health and the crown contour.

Every restorative material used in the oral cavity (metal, ceramic, or acrylic resin) has the potential to attract plaque deposits. Due to the chemical and physical properties of each material, the composition and retention of accumulated plaque and the following periodontal reaction will differ from material to material and patient to patient. Porcelain, due to its chemical composition, is a highly biocompatible material that displays a low affinity to soft debris accumulation (19).

Vered Y et al 2011, compared implants and contralateral natural teeth and was looking at clinical health indices and microbiological parameters and found that plaque around natural teeth was higher compared to dental implants. A tendency for higher gingival inflammation and BoP on natural teeth compared to dental implants was also found (37,38).

Peri-implant mucositis has been defined as a reversible inflammatory process in the soft tissues surrounding a functioning implant, whereas peri-implantitis is an inflammatory process additionally characterized by loss of peri-implant bone. A sub-gingival biofilm formation has been shown in animal experiments and clinical studies to be an important etiologic factor for the initiation of perimplant inflammation and subsequent loss of marginal bone (39–41).

It has been found that the inflammatory and immune responses of the peri-implant mucosa were similar to that of the periodontal tissues of natural teeth in reaction to biofilm originated bacteria and pathogens. Therefore, it may be assumed that the peri-implant tissue response to the bacterial challenge may follow patterns comparable to that of the periodontal tissues in a susceptible host (42). So far, it has not yet been clarified whether or not a host susceptible for periodontitis will also be susceptible for peri-implantitis. However, there is evidence for the association between periodontitis and peri-implantitis in a few reports (Mombelli et al. 1995, Ellegaard et al. 1997, Karoussis et al. 2003) (42).

Inflammation of peri-implant hard and soft tissues triggered by bacterial biofilms is now regarded as one of the principal problems in dental implantation with the highest incidence of implant loss within the first 12 months (43).

These bacteria, as well as Aggregatibacter actinomycetemcomitans or Porphyromonas gingivalis, have been frequently isolated from diseased periodontal or peri-implant sites and have been designated as highly relevant for the development of chronic periodontal or peri-implant inflammatory processes (43).

The pathological processes as well as the bacterial flora at implants and periodontitis-affected teeth have been described in detail, supporting the theory that a cross-contamination from the dentition to implants takes place, endangering non-inflamed conditions at implant sites (43).

EVALUATION OF THE PERI-IMPLANT MARGINAL TISSUES

Plaque Assessment

Mombelli and coworkers (30) modified the original Plaque Index introduced by Silness and Löe (44) to assess biofilm formation in the marginal area around implants (mPI). Lindquist and associates (45) evaluated oral hygiene levels according to a 3-point scale and described a significant relationship between oral hygiene and peri-implant bone resorption over an observation period of 6 years.

Mucosal Conditions

Swelling and redness of the marginal tissues, bleeding on probing (BOP), pocket formation, and suppuration has been reported to result from peri-implant infections (30).

The definition of peri-implant parameters based on periodontal indices such as the Gingival Index System (GI) seems indicated (46). The GI has been modified and adapted (mGI) for application around oral implants (30), while a simplified GI has been proposed by Apse and associates (47).

Peri-Implant Probing

Histologically, the peri-implant mucosa is similar to the periodontal mucosa around natural teeth, composed of a well-keratinized oral epithelium, sulcular epithelium, and a thin barrier epithelium facing the abutment corresponding to the junctional epithelium around teeth, termed the peri implant junctional epithelium.
The height of the peri-implant junctional epithelium is approximately 2 mm, and the connective tissue underlying this junctional epithelium is around
1.0 to 1.5 mm. Thus, the mean biological width (including the sulcus depth) may often exceed 3 mm (48).

The importance of either tooth or peri-implant probing has been well documented in the literature. One of the early quantifiable differences between these 2 structures is the deeper mean in probing depth at implant sites compared with tooth sites (48).

Slight increases in pressure may sometimes result in injury when the probe goes beyond the peri-implant seal (49). It is important, however, to note that not all investigators agree with the drastic changes of probing depth between implants and teeth (50), although the general consensus is that probing depth is increased in implant sites, BOP is also more sensitive to minor changes in pressure in implant sites (49).

Radiographically determined bone changes and probing depth (PD) changes and are used to estimate stability of sites or progression of disease around natural teeth. These parameters are further utilized for implants and may show considerable results in terms of periodontal stability even though there are still limitations with respect to diagnostic accuracy (51–54).

Existence or absence of Bleeding on Probing (BOP), suppuration and visible plaque, these parameters have been applied recently, for implant sites during maintenance (55). Even though Bleeding on Probing (BOP) might have a limited predictive value for disease progression (56).

4- CAD/CAM – History

Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) was first employed for the aviation and automotive manufacturing industries in the 1960’s and was first utilized in the field of dentistry on an experimental level approximately 10 years later.

The first CAD/CAM system used in dentistry was the Sopha system, which was developed by Francois Duret of France in 1984. It involved an optical scanner that obtained a digital impression of the prepared tooth, a computer with the required software to plan a restoration and lastly a numerically controlled milling machine that fabricated the designed restoration (57).

CEREC, a commercialized intraoral scanner (IOS), made it possible to digitize the dental status in situ (58,59). Since the late 2000's, there has been a rapid increase in the number of commercial IOS with scanners capable of capturing full dental arches (60).

R. Nedelcu et al, performed a study to evaluate and assess in vivo the accuracy of 3 intraoral scanners 3M True Definition (3M), CEREC Omnicam (OMNI) and Trios 3 (TRIOS) and conventional impressions and concluded that 3M and TRIOS had a high accuracy for full arch scans and they can be used as a replacement for conventional impressions when restoring up to ten units without extended edentulous spans (61).

Beatriz et al 2016, studied the accuracy and repeatability of true definition scanners on full arch implant scans and found that the TrueDef scanner provides measurements within clinically accepted limits (62).

The importance of ideal emergence angle is irrefutable however, the information on the range of acceptable emergence angle in a restoration is lacking. Therefore, the specific aims of this retrospective study were 1) to compare the emergence angle of a SIC of the mandibular first molar to the emergence angle of the natural contralateral tooth, 2) to evaluate the effect of the emergence angle of SIC on the health of the peri-implant soft tissue and 3) to quantify an acceptable emergence angle among SIC.

The null hypotheses were that variation in emergence angle has no effect on the surrounding peri-implant tissue in regards to PI, PD, or BOP.

CHAPTER III

MATERIAL AND METHODS

Approval was requested and granted by Marquette University Internal Review Board (HR-3296). The study protocol consisted of identifying Marquette University Dental School (MUSoD) patients who had an implant and a SIC restoration placed from 2010-2015 in the mandibular first molar site, and where the implant restoration was inserted and in function for at least 6 months. The patient information was gathered from electronic health record (Axium) by corresponding procedure codes: D6010, D6057, D6059 and D6058. Inclusion criteria included patients who were above 18 years of age and who have existing natural teeth along with a single implant restoration in the first molar site of the mandibular arch. In addition, the SIC should be in function at least for 6 months, with the presence of unrestored natural contralateral tooth on the same arch

Exclusion criteria consisted of presence of systemic disease, uncontrolled periodontitis and presence of active infection for example, peri-implantitis, pus, fistula, mobility around the implant or infection around natural teeth.

A total of 1800 patient records were obtained and their data were screened to determine their eligibility for the clinical examination. Out of the 1800, 28 patients' records met the eligibility criteria for clinical examination. Potential subjects were contacted by phone by the clinic coordinator.

After obtaining verbal agreement from the patients, they were seen in the clinic for the an exam, and inclusion criteria was verified. Study design was explained to the patients who met the inclusion criteria and consent was signed.

A total of 10 patients consented to participate in the study. The following data were collected from these ten patients. Patient data, for example, name, age, gender, blood pressure, history of smoking, use of bisphosphonates and implant data, for example, implant site, brand, date of implant placement and date of restoration placement and type of restoration- screw/cement retained restoration, history of technical failure information was collected. Digital impressions were made with the Lava True Definition intraoral scanner (3M ESPE). Before scanning, the mandibular teeth were sprayed with titanium oxide powder provided with the scanner. One operator captured all the scans. After all the scans are completed, the information was sent to the production center (Lava; 3M ESPE) to obtain the STL files. A polyvinyl siloxane impression (Imprint 3 Medium Body "Monophase") (3M ESPE) of the mandibular arch was made and stone model (ISO Type 3 buff stone)(Whip Mix) was fabricated as a back up for the intraoral scan. The following clinical measurements were obtained from the natural tooth and implant crown: plaque index, probing depth and bleeding on probing. All the clinical data were collected by a single examiner and recorded in an Excel spreadsheet for later analysis

Clinical assessment

Clinical assessments of the dental implant and natural teeth included:

a. Plaque index (PlI) for the natural tooth (45).
b. Modified plaque index (mPlI) for the implant (30).
c. Bleeding index for natural teeth (BI) (45).
d. Modified bleeding index (mBlI) for the implant (30).
e. Probing pocket depth (PPD) in millimeters (49).

Plaque index (PLI) was assessed at 6 aspects around the implants. A modification of the Silness and Löe plaque index was used as described previously in the literature. For each implant, a single PLI value was calculated based on the average of the four obtained values. A score of 0 indicates no detection of plaque, 1- plaque is only recognized by running a probe across the smooth marginal surface of the implants, 2 - that plaque can be seen by the naked eye and 3- there is abundance of soft matter (45).

Bleeding on probing (BOP) was scored around implant and natural teeth at 6 sites, mesially, centrally, distally, buccaly and lingually as 1 if bleeding is present and 0 if absent (31,32).

Probing depth (PD) was assessed at 6 sites, mesially, centrally, distally, buccaly and lingually, around SIC and the contralateral natural tooth. A calibrated periodontal probe (Michigan O probe with Williams markings) was used with a slight force of 0.2 to 0.3N (30).

Emergence profile measurement

Intra oral scan of the mandibular arches with scanner was obtained for each patient. After the intraoral scanning data acquisition, the 3D mesh from the patient mandibular arch was saved in Stereo Lithography (STL) file. The 3D mesh was treated and cleaned with Autodesk Remake (Fig. 1). The final mesh has about 300,000 triangles, which allows an accurate angle measurement.

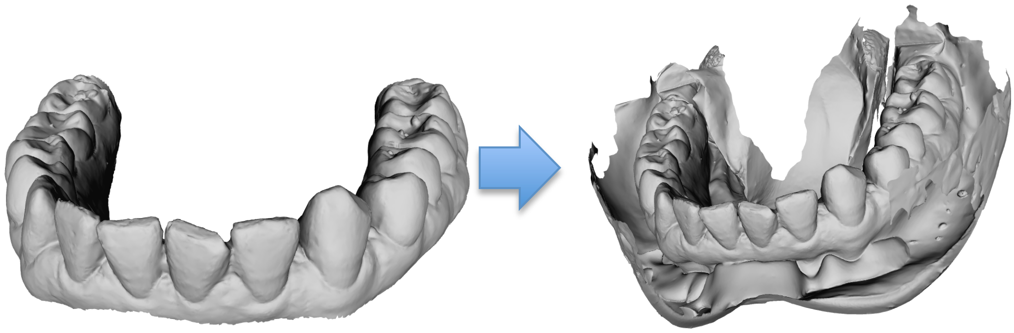
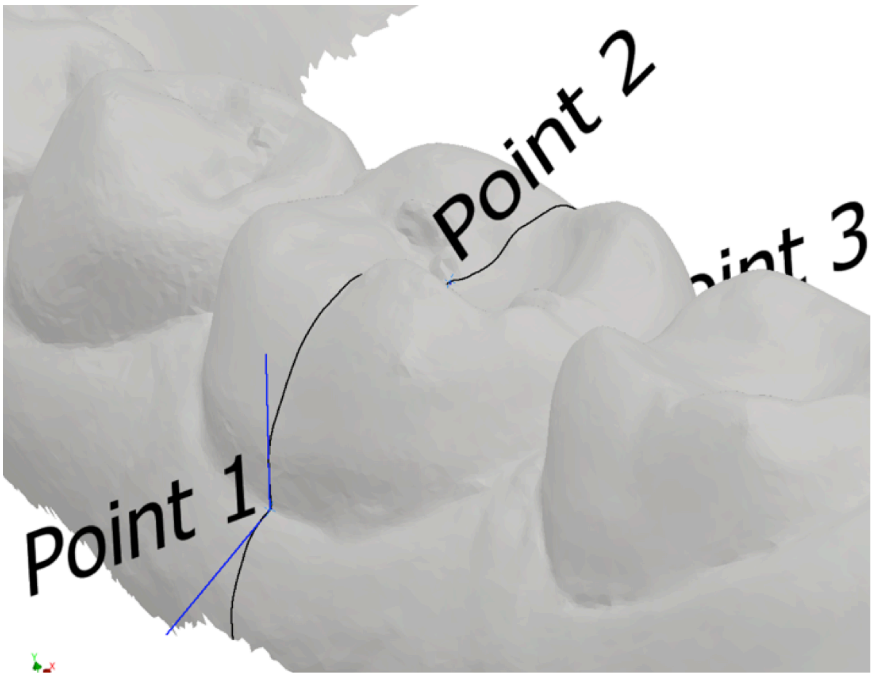


Figure 1. Treatment and cleaning process from the patient 3D mesh.

To create the tooth mid-plane, it is necessary to define 3 points that are not aligned (Fig. 2a). This task is completed using an iterative point selection and validating the mid-plane created by visual inspection from different views. Point 1 is located on the facial and is the mid-point of the line contacting the buccal tooth surface and the buccal gingiva. Point 2 is the mid-point of the occlusal surface of the tooth. Point 3 (Fig. 2b) is located on the lingual and is the mid-point of the line contacting the lingual tooth surface and the lingual gingiva.



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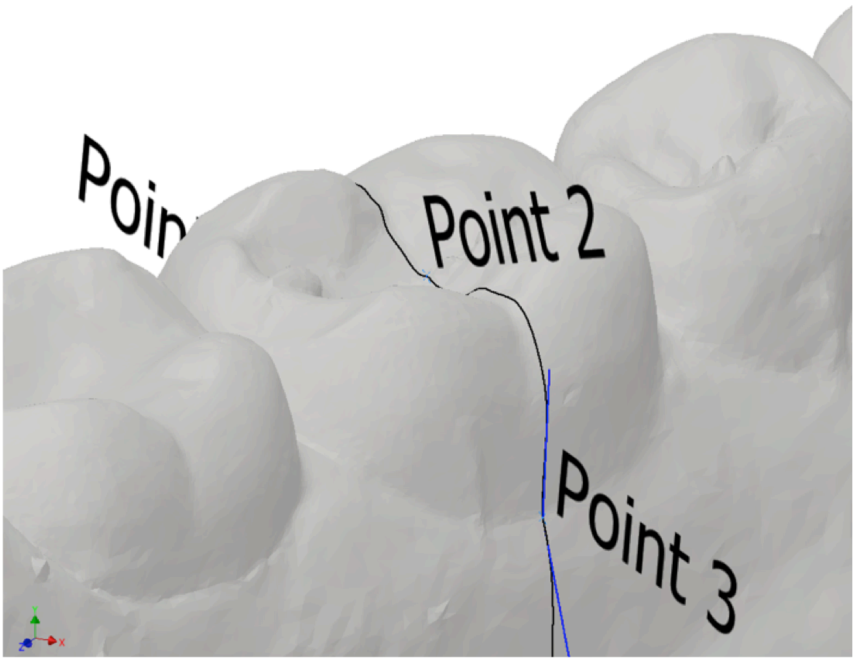


2 b

Figure 2 a and b. Point selection for the tooth mid-plane.

After defining the 3 points above, a mid-plane is created by joining the 3 points as shown in Figs. 2a and b. On the newly created mid-plane, tangent lines are drawn to the tooth surface and gingiva on the buccal and lingual surfaces at points 1 and 3 respectively (Fig. 3). The angle formed between the tangent lines on the buccal and lingual surface is the emergence angle of the tooth at the mid-plane.

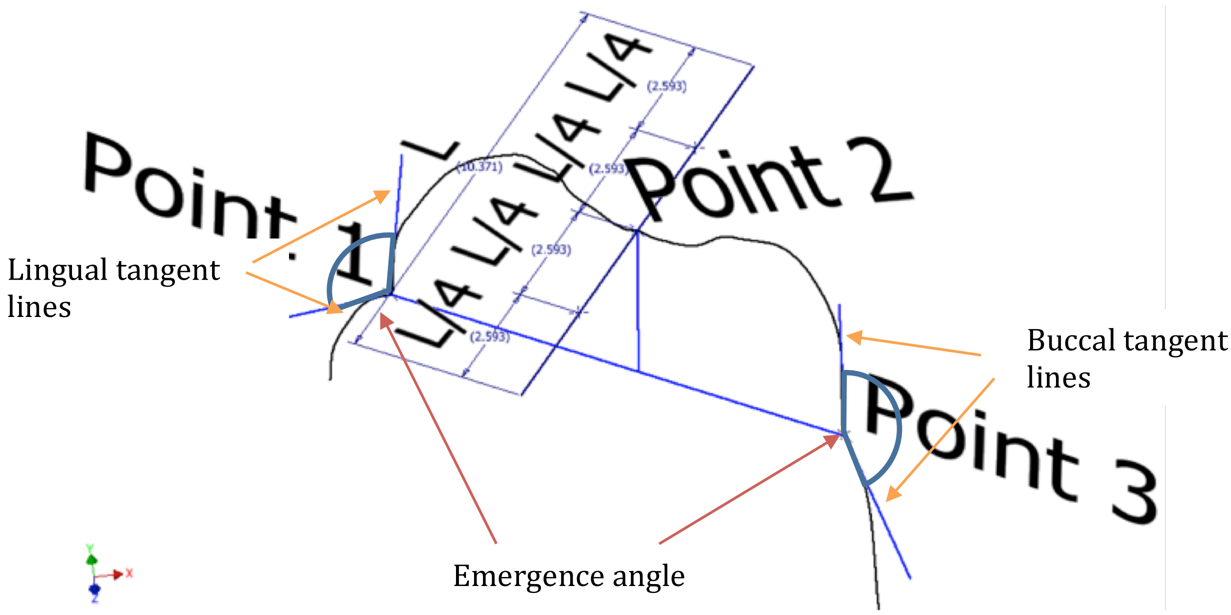


Figure 3. Tooth contour from the tooth mid-section and angle measurement.

A line is drawn on the superior edge of the tooth perpendicular to the mid-plane (Fig. 4). *L* is the total length of the superior edge of the tooth (Fig. 4). This line is bisected by the mid-plane on the superior edge. 2 additional parallel planes further divide each half on the superior edge.

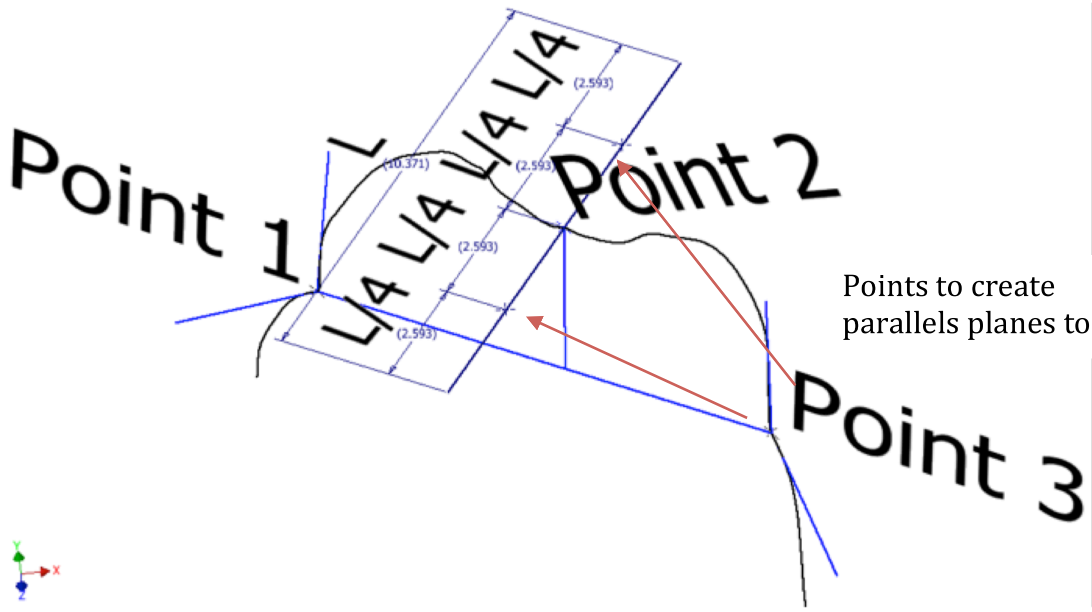
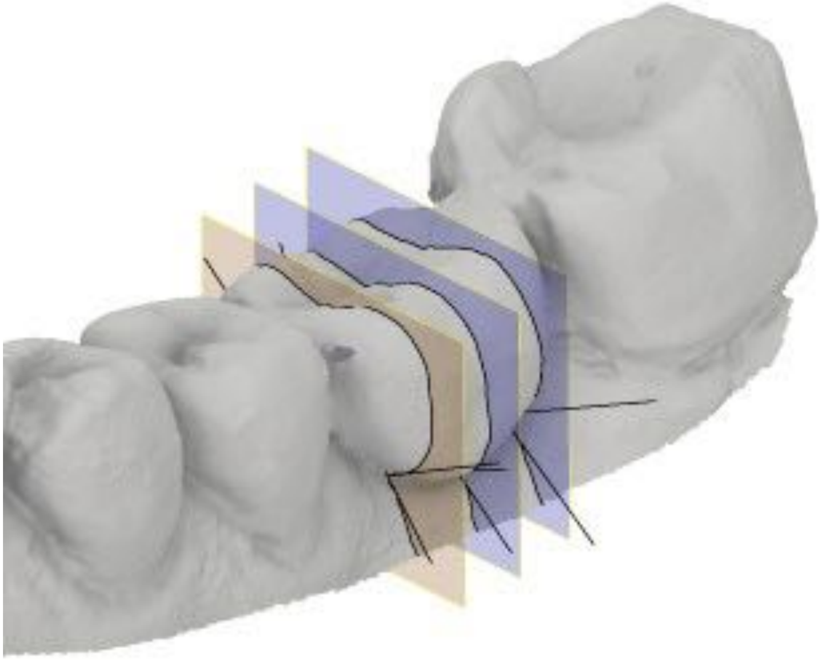


Figure 4. Division of the superior tooth edge in 4 equal parts

These 2 additional planes will therefore be *L/4* distance away from the mid-plane (Fig. 5). Tangents were drawn on the 2 additional planes (similar to the tangents drawn on the mid-plane) to obtain 4 additional emergence angles. Each crown of the implant and contralateral natural tooth will have 3 planes and 6 emergence angles. Creating 3 planes on the tooth in this manner assures the same proportion irrespective of the tooth size and makes it possible to compare the emergence angles on a natural tooth to an implant crown.



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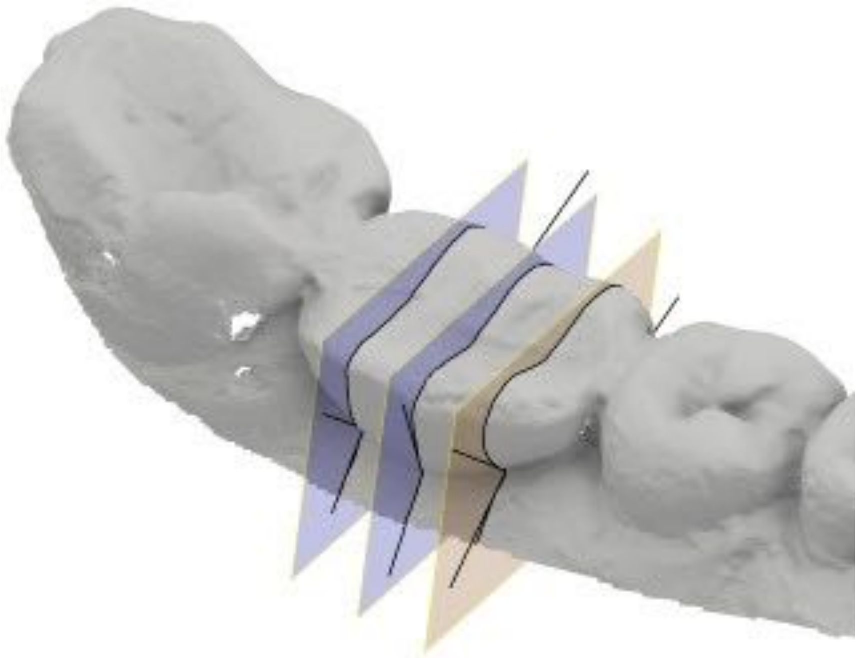

5 b

Figure 5 a and b. Three vertical sectioning planes

Tangents were drawn on the 2 additional planes (similar to the tangents drawn on the mid-plane) to obtain 4 additional emergence angles. Each crown of the implant and contralateral natural tooth will have 3 planes and 6 emergence angles. Creating 3 planes on the tooth in this manner assures the same proportion irrespective of the tooth size and makes it possible to compare the emergence angles on a natural tooth to an implant crown.

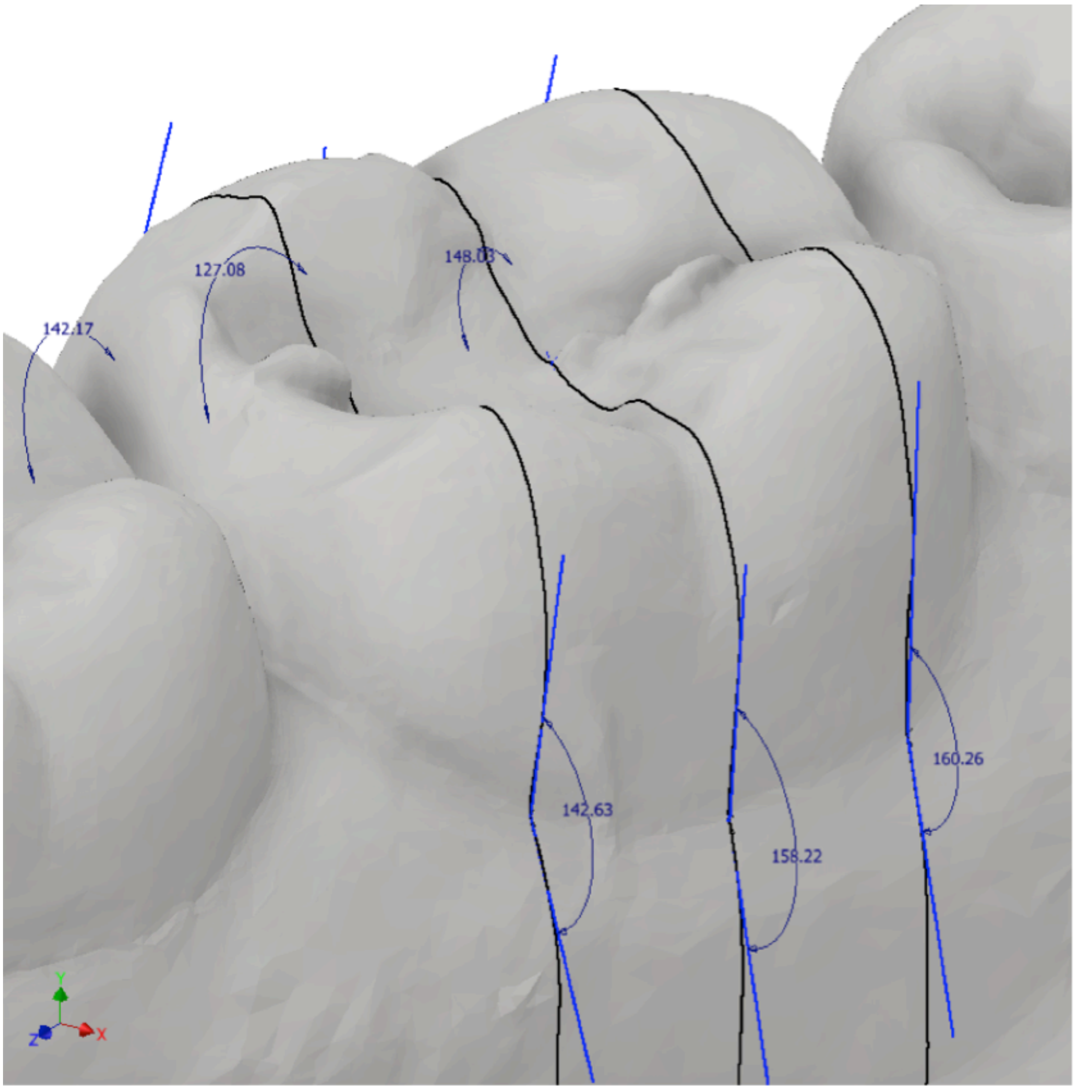

Figure 6. Six angle measurements on the right mandibular first molar - 3 on the buccal and 3 on the lingual

Autodesk Inventor Professional 2018 was used to measure the angle between the natural tooth (or implant tooth) and the gingival contour. This software is based on the techniques of Computer-Aided Engineering (CAE), which helped create 3 vertical sections and measure of the angles on each tooth, as shown in figure 5 and 6.

The emergence angles were matched with the clinical data obtained from the corresponding tooth to evaluate the effect of the emergence angle of SIC on the health of the peri-implant soft tissue. An emergence angle that supports healthy peri-implant hard and soft tissue around a SIC was determined.

Statistical analysis

One examiner (P.I) collected all the clinical, intra-oral scans and demographic data. Another examiner (C.P.I) collected the data for angle measurements.

These data were recorded in a spreadsheet (Excel 2011, Microsoft). All statistical computations were done in IBM SPSS 24 and Sigmaplot 12.5.

Statistical analyses were performed to compare the angles of emergence, and clinical variables.

Natural tooth and implant crown angle measurements using Pearson Correlation Coefficient at 6 locations (BMesial, BMid, BDistal, LMesial, LMid, LDistal) and at 4 locations (BMid vs BMesial, BMid vs BDistal, LMid vs LMesial, LMid vs LDistal).

ANOVA was used to analyze the emergence angles, PI, PD, and BOP with other variables of this research like the location of the implant (left/right) and the restoration type (cement or screw).

Paired samples Student Test was used for comparing (emergence angle vs PI, PD, BOP) and (PI vs PD vs BOP) (P value of <0.05).

Sample Size

A total of 10 patients, who met the clinical inclusion criteria and were enrolled in the study.

CHAPTER IV

RESULTS

Demographic data

Ten patients participated in the study (6 males and 4 females), mean age was 56.6 years, 2 patients were diagnosed with hypertension, and none of the 10 patients was diagnosed with diabetes. None of the patients smoked and 6 out of 10 drank alcohol occasionally (2-3 times per week). Implants were present at site number 19 (left mandibular first molar) on 6 patients and 4 were at site number 30 (right mandibular first molar). Implants were placed between October 2010 to October 2016. Implants' crowns were inserted between February 2011 to July 2016. Three crowns were screw retained and 7 were cement retained, and two technical complications were present (1 crown recementation, 1 chipping).

Patients reported that they brushed their teeth 2 times a day on average and using dental floss at least once a day. All patient reported that they were on a regular 6 month schedule with hygiene visits. Nine patients were right-handed and 1 patient is left-handed.

Emergence angle

Angle analysis in degree (0)

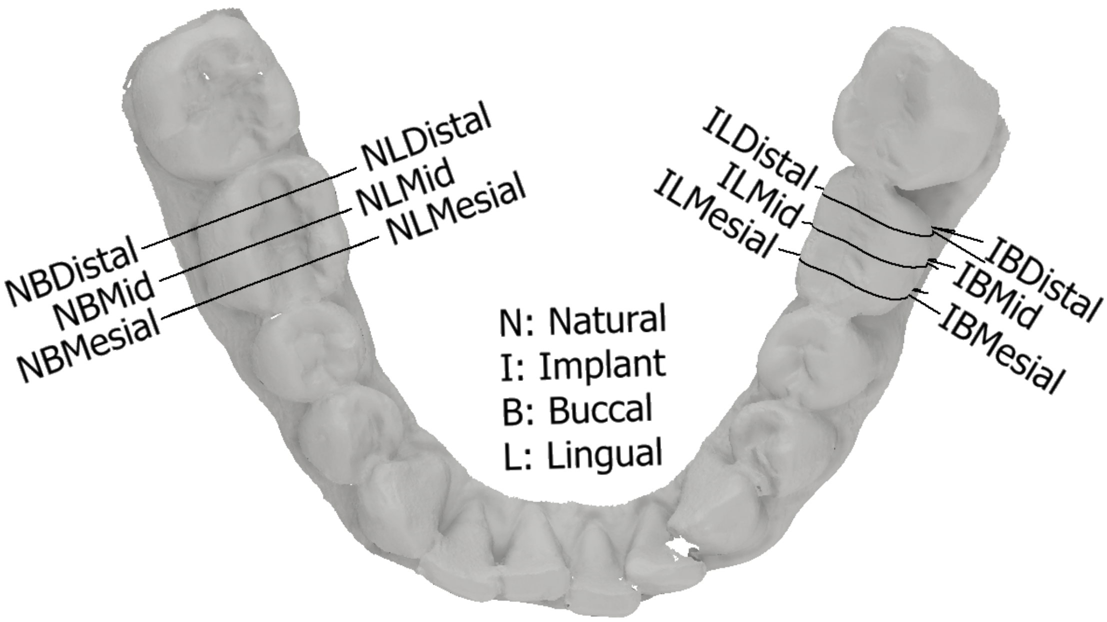

Figure 7. The nomenclature for the six angles on the implant crown and contralateral natural tooth

Tables 1,2. Mean and standard deviations for angle measurements on 6 surfaces

Natural teeth.

	NBDistal	NBMid	NBMesial	NLDistal	NLMid	NLMesial
Mean (degrees)	105.63	99.1	104.8	117.4	117.5	121.6
Standard deviation	19.56	24.3	21.9	18.41	24.1	15.4

Implant teeth.

	IBDistal	IBMid	IBMesial	ILDistal	ILMid	ILMesial
Mean (degrees)	113.9	106.3	104.9	121.3	133.1	118.7
Standard deviation	25.8	25.4	22.7	23.8	21.2	18.7

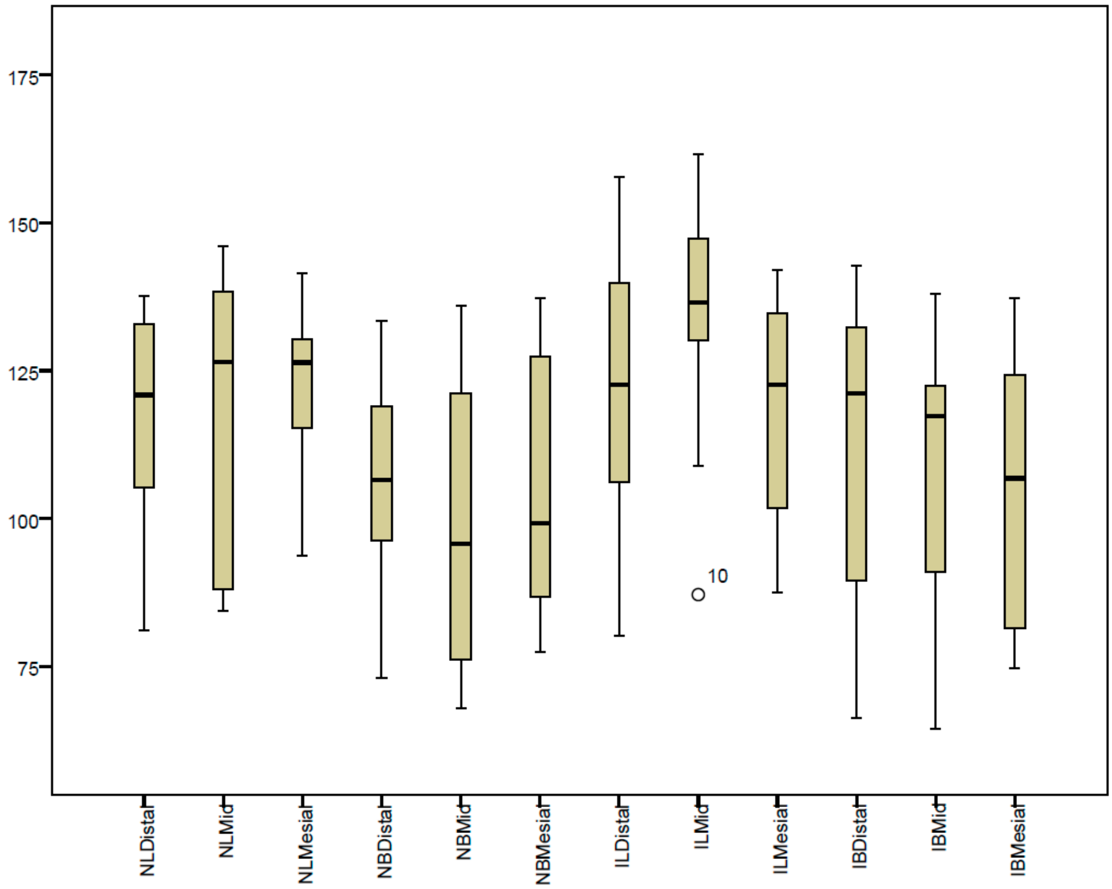

Figure 8. Box graph of emergence angles.

Mean emergence angle measurements showed lingual angles to be greater than the buccal angles, both on natural teeth and implant crown. Also, the mean angle measurement on implant crowns was found to be greater than their natural counterparts on both buccal and lingual surfaces.

However, the standard deviation values were great, meaning that the data has a wide distribution for each variable; hence the statistical analysis could be more difficult to achieve clear conclusions from with diverse statistical tests.

The correlation of Pearson was used to find correlation between the variables. The emergence angles of the Mid-section plane from the natural and implant teeth showed a significant Pearson correlation, except for 2 pairwise: NBMid vs ILMid and ILMid vs IBMid. Probably, the most interesting aspect from the correlation is the

NLMid vs NBMid with Pearson value of 0.7 showing a strong correlation with significance level of 0.02 due to the opposite ILMid vs IBMid which is not correlated. The rest of pairwise didn't show correlations. This distribution with the regression lines can be observed in the scattering chart.

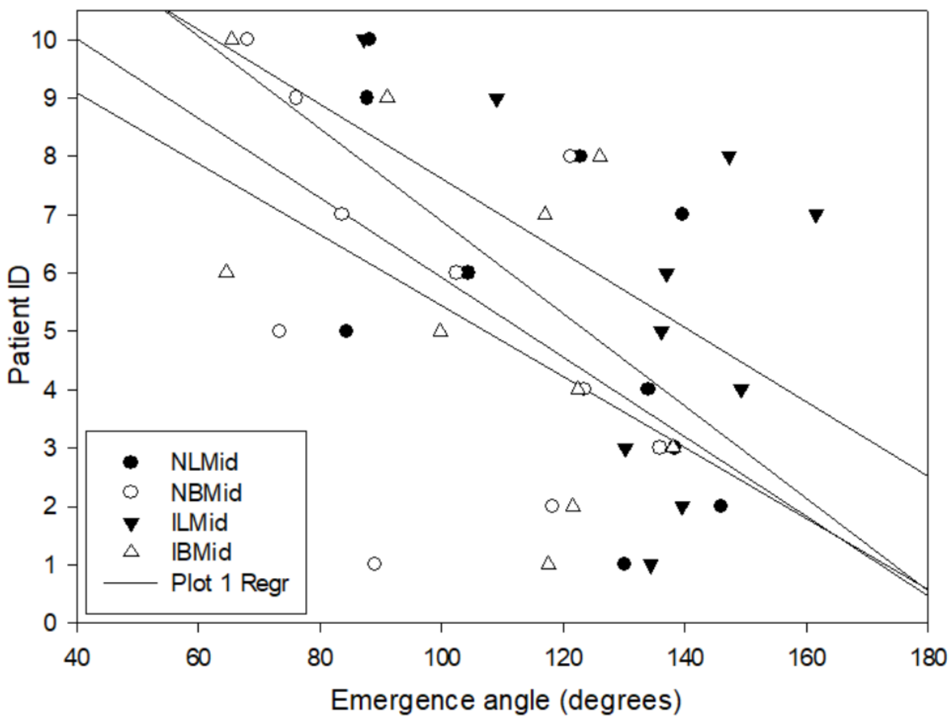

Figure 9. Scattering graph with regression lines.

In order to find significant correlation between the angles, subtraction of the mesial and distal angles from the middle angle on the buccal and lingual of natural tooth and implant crown was used to demonstrate the progressive change in the angles between the six areas.

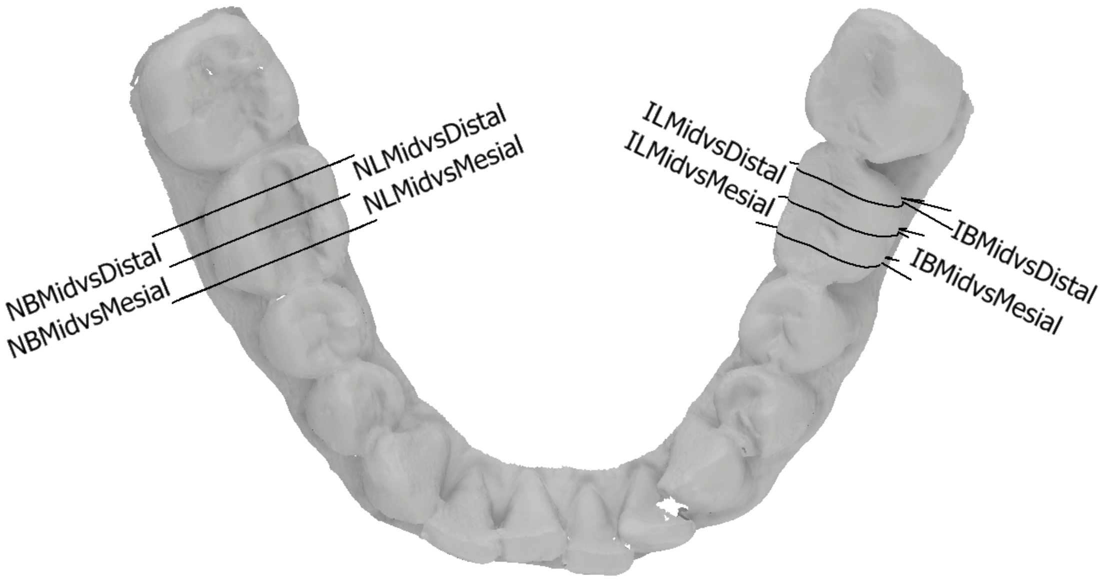

Fig 10. Nomenclature for the 4 angle subtractions on the implant crown and contralateral natural tooth

Tables 3,4. Mean and standard deviations for angle subtractions on four surfaces

Angle subtraction on natural teeth.

	NBMidvsDistal	NBMidvsNBMesial	NLMidvsDistal	NLMidvsMesial
Mean (degrees)	0.2	-4.1	-6.5	-5.7
Standard deviation	11	17.9	19.6	16

Angle subtraction on implant teeth.

	IBMidvsDistal	IBMidvsMesial	ILMidvsDistal	ILMidvsMesial
Mean (degrees)	11.8	14.4	-7.6	1.4
Standard deviation	16.1	14.3	14.6	12.9

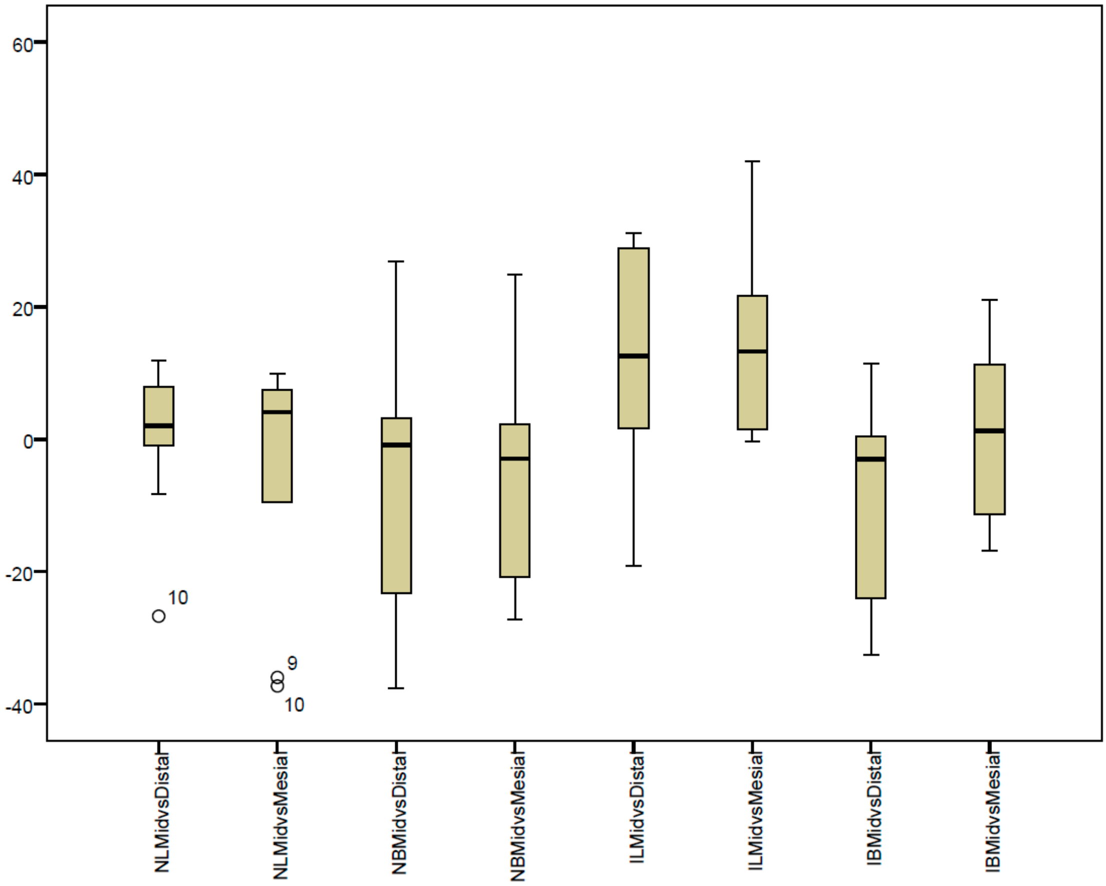

Figure 11. Box graph of the subtractions.

Mean measurement of angle subtractions, showed lingual angle subtraction to be lower on natural teeth than implant crowns. Therefore, the progressive angle change on the lingual side of implant crowns is more evident than on natural teeth. Also, the progressive angle change on the lingual side of implant crowns is more evident than on the buccal side.

Based on the angle subtraction analysis, the NLMidvsMesial vs NBMidvsMesial correlation shows a very high Pearson value and high level of significance confirming the previously mentioned Mid-section correlation in the natural tooth.

However, this correlation is shown between Mid-section plane and Mesial-section plane. The absence of correlation between the emergence angles in implant teeth is also confirmed.

Plaque index

Table 5. Shows the mean and standard deviations for plaque index measurements around natural teeth, statistically insignificant difference was noted between buccal and lingual surfaces.

	PI.NBMesial	PI.NBMid	PI.NBDistal	PI.NLMesial	PI.NLMid	PI.NLDistal
Mean	1.2	1.1	1.2	1.2	1.2	1.2
Std Dev	0.4	0.3	0.4	0.4	0.4	0.4

Table 6. Shows the mean and standard deviations for plaque index measurements around implant crowns, statistically insignificant difference was noted between buccal and lingual surfaces.

	PI.IBMesial	PI.IBMid	PI.IBDistal	PI.ILMesial	PI.ILMid	PI.ILDistal
Mean	1.1	1.1	1	1.1	1.2	1.1
Std Dev	0.3	0.3	0	0.3	0.4	0.3

Analysis of plaque index to (implant location & restoration type) using ANOVA tests

No significant difference was found regarding the implant location or restoration type (cement or screw) in relation to PI.

Analysis of emergence angle & PI using Paired samples Student Test

All variables were statistically different, meaning that emergence angle and PI are independent with showing no correlation between variables.

Analysis of BOP & PI using Paired samples Student Test

Paired samples correlation showed 1 correlation (PI.IBMid & BOP.IBMid) with p value of 0.035.

Analysis of PD & PI using Paired samples Student Test

Paired samples correlation showed 2 correlations: PI.NBMid & PD.NBMid and PI.IBMid & PD.IBMid with p values of 0.035 and 0.032 respectively.

Probing depth

Table 7. Shows the mean and standard deviations for probing depth measurements around natural teeth, statistically insignificant difference was noted between buccal and lingual surfaces.

	PD.NBMesial	PD.NBMid	PD.NBDistal	PD.NLMesial	PD.NLMid	PD.NLDistal
Mean (mm)	2.8	1.7	2.6	3.1	2.1	2.9
Std Dev	0.9	0.7	0.5	0.9	0.7	0.9

Table 8: shows the mean and standard deviations for probing depth measurements around implant crowns, statistically insignificant difference was noted between buccal and lingual surfaces.

	PD.IBMesial	PD.IBMid	PD.IBDistal	PD.ILMesial	PD.ILMid	PD.ILDistal
Mean (mm)	3.3	2.8	2.6	3	2.3	3
Std Dev	1.2	0.4	0.5	0.8	0.7	1.2

Analysis of probing depth to (implant location & restoration type) using ANOVA tests

A difference of statistical significance was found regarding PD to implant crowns on the right side (PD.NBMid) with p value of 0.024. Whereas, restoration type (cement or screw) showed no significant differences on PD.

Analysis of emergence angle & PD using Paired samples Student Test

Paired samples correlation showed no correlation between emergence angle & PD.

Analysis of PD & BOP using Paired samples Student Test

Paired samples correlation showed 3 correlations (BOP.NLDistal & PD.NLDistal), (BOP.ILDistal & PD.ILDistal), and (BOP.ILMesial & PD.ILMesial) with p values of 0.014, 0.006, and 0.001 respectively.

Bleeding on Probing

Table 9. Shows the mean and standard deviations for bleeding on probing measurements around natural teeth, statistically insignificant difference was noted between buccal and lingual surfaces.

	BOP.NBMesial	BOP.NBMid	BOP.NBDistal	BOP.NLMesial	BOP.NLMid	BOP.NLDistal
Mean	0.3	0.2	0.4	0.1	0	0.1
Std Dev	0.5	0.4	0.5	0.3	0	0.3

Table 10. Shows the mean and standard deviations for bleeding on probing measurements around implant crowns, statistically insignificant difference was noted between buccal and lingual surfaces.

	BOP.IBMesial	BOP.IBMid	BOP.IBDistal	BOP.ILMesial	BOP.ILMid	BOP.ILDistal
Mean	0.4	0.2	0.2	0.1	0.2	0.3
Std Dev	0.5	0.4	0.4	0.3	0.4	0.5

Analysis of bleeding on probing to (implant location & restoration type) using ANOVA tests

No significant difference was found regarding the implant location or restoration type (cement or screw) in relation to BOP.

Analysis of emergence angle & BOP using Paired samples Student Test

Paired samples correlation showed 2 correlations between emergence angle & BOP (IBMid & BOP.IBMid and IBMesial & BOP.IBMesial) with p values of 0.029, and 0.001 respectively.

CHAPTER V

DISCUSSION

The comparison of emergence profile angles of SIC and contralateral natural tooth made by CAD/CAM technology was investigated, as well as, the effect of emergence profile angles on the health of the periodontal tissues, specifically PI, PD, BOP. The present study was designed to test the relationship between angle measurements of SIC and the contralateral natural tooth by using the Lava True Definition intraoral scanner. Three areas on buccal and lingual surfaces of the crowns of mandibular first molar (mesial, middle, distal) and four areas of progressive angle change (middle vs mesial, middle vs distal) were tested and compared.

Emergence angle

Phillips et al. stated that an implant restoration needs to be in harmony with the crown form of the adjacent natural teeth as well as with the contralateral natural tooth (10).

Takei et al, and Parkinson et al, looked at the plaque indices of crowned posterior teeth and compared the data to that for unrestored contralateral teeth. They concluded that, to predict a favorable prognosis, an artificial crown form must approximate natural tooth morphology (12,13).

The current results of the study showed, among the patients enrolled in this study, that there is a probable similarity between the buccal and lingual surface emergence angle means of natural and implant crowns with no statistically significant differences.

Table 11. Comparison of mean emergence angles between SIC and contralateral natural tooth.

Mean (degrees)	Natural teeth.	Implant teeth.
LDistal	117.4	121.3
LMid	117.5	133.1
LMesial	121.6	118.7
BDistal	105.6	114
BMid	99.1	106.3
BMesial	104.8	104.9

Based on the mean of angle measurements, the lingual angles were greater than lingual angles mean on natural teeth and implant crowns resulting in over-contoured buccal surfaces in comparison to lingual surfaces.

The mean angle measurements on implant crowns were greater than their counterparts on natural teeth buccaly and lingually except on LMesial surface resulting in under-contoured surfaces on implant crowns in relation to natural teeth.

Theses results were similar to the findings of a previous study conducted by B. M. Croll in 1989, looking at the anatomy of several hundreds natural teeth, which he found that the natural teeth demonstrated that the lingual surfaces of mandibular molar were under-contoured in relation to the buccal surfaces (16).

Plaque index

Table 12. Comparison of mean plaque index between SIC and contralateral natural tooth.

Mean (value)	Natural teeth.	Implant teeth.
BDistal	1.2	**1.1**
BMid	1.1	**1.1**
BMesial	1.2	**1.1**
LDistal	1.2	**1.1**
LMid	1.2	**1.2**
LMesial	1.2	**1.1**

Based on the results of the current study, mean PI values comparison between SIC and the contralateral natural tooth, the values present were similar with a value ~1 (plaque is only recognized by running a probe across the smooth marginal surface of the SIC and contralateral natural tooth). This could be attributed to the close resemblance of implant crowns emergence angles to the contralateral natural teeth.

These results were opposite to Vered Y et al 2011, where the PI was more around natural teeth with mean value of 1.85 in comparison to SICs with mean value of 2.15.

The mean PI values were fairly similar with no statistical deference between the undercontoured buccal surfaces in relation to the overcontoured lingual surfaces on both SIC and contralateral natural tooth.

However, paired samples correlation showed one correlation between PI & BOP on the midbuccal surface of the implant crown. This could be attributed to the fact that the artificial crowns tend to attract more plaque than contralateral natural teeth. This result was in agreement with the results of Vered Y et al 2011.

Paired samples correlation showed no correlation between emergence angles and PI; confirming the null hypothesis that variation in emergence angle has no effect on the surrounding peri-implant tissue in regards to (PI). However, theses results are consistent to the findings of previous studies on natural teeth conducted by Parkinson in1976, Jameson et al in1982, and Sundh et al 2002**,** where they concluded that PI is expected to be lesser on undercontoured surfaces in comparison to overcontoured surfaces (33,20,25), this could be due to the clinical observations that the implant crown and natural teeth angles were similar to each other and we expect the PI to be minimal.

Probing depth

Table 13. Comparison of mean probing depth between SIC and contralateral natural tooth.

Mean (depth in mm)	Natural teeth.	Implant teeth.
BDistal	2.6	2.6
BMid	1.7	2.8
BMesial	2.8	3.3
LDistal	2.9	3
LMid	2.1	2.3
LMesial	3.1	3

Based on the results of the current study, mean PD values comparison between SIC and the contralateral natural tooth, were fairly close to each other with mean deference of + 0.3 mm around SICs. Which was in agreement with the results of Mombelli et al 1997 where he found deeper PD of mean + 0.8 mm around SIC compared to natural teeth (49).

Based on the results of the current study, paired student test does not show significant deference in PD between SIC and the contralateral natural tooth, except for mid buccal surface.

However, Paired samples correlation showed two correlations between PD & PI on the mid buccal surfaces of SIC and the contralateral natural tooth. Which were in agreement with the results of Parkinson1976, and Lindquist 1988 (30, 45).

Paired samples correlation showed no correlation between emergence angles to PD. Which is confirming the null hypothesis, that variation in emergence angle has no effect on the surrounding peri-implant tissue in regards to (PD). However, theses results are consistent to the findings of previous study on natural teeth conducted by Parkinson in1976**,** where he concluded that gingival indices are expected to be lesser on undercontoured surfaces in comparison to overcontoured surfaces (33), this could be due to the clinical observations that the implant crown and natural teeth angles were similar to each other and we expect the PD to be minimal.

Bleeding on probing

Vered Y et al 2011, compared implants and contralateral natural teeth and was looking at clinical health indices and microbiological parameters and found that Plaque around natural teeth was higher compared to dental implants. A tendency for higher gingival inflammation and BoP on natural teeth compared to dental implants was also found (36,37).

Table 14. Comparison of mean BOP between SIC and contralateral natural tooth.

Mean (value)	Natural teeth.	Implant teeth.
BDistal	0.4	0.2
BMid	0.2	0.2
BMesial	0.3	0.4
LDistal	0.1	0.3
LMid	0	0.2
LMesial	0.1	0.1

Based on the results of the current study, mean BOP values comparison between SIC and the contralateral natural tooth, the values present were similar with no significant deference. Which was opposite to the results of Mombelli et al 1997 where he found more BOP around 11 SIC compared to the contralateral natural teeth.

Paired samples correlation showed three correlations between BOP and PD on the distolingual surface of the contralateral natural tooth, and the distolingual and mesiolingual surfaces of SIC. Which were in agreement with the results of Parkinson's study in 1976 (33).

However, paired samples correlation showed two correlations between emergence angles to BOP on the mesiobuccal and midbuccal surface of the implant crown. Which is rejecting the null hypothesis, and demonstrating an effect of the overcontoured surfaces with an emergence angle of ≤ 106 degrees of the implant crown on BOP. However, theses results are consistent to the findings of previous study on natural teeth conducted by Parkinson in1976**,** where he concluded that gingival indices are expected to be greater on overcontoured surfaces in comparison to undercontoured surfaces (33)

There are several advantages to this study; a novel approach of measuring the emergence angle utilizing an intraoral scanner was introduced. This is the first study to look for the relationship of emergence angle of SICs on (PI, PD, BOP)

However, there are limitations of this research with respect to methods, materials, and number of subjects examined. Future scope for research in this topic would be to repeat the same study by recruiting a larger number of patients and by using a more sophisticated intra oral scanner that does not require a powder spray over the teeth; this was an issue especially in patients with excessive salivary flow. Another aspect to consider in future research is including white and pink esthetic scores (WES, PES) into the comparisons.

The current study used only mandibular first molar teeth, the study could possibly be repeated with premolars, anterior, and maxillary teeth and evaluates the possibility of difference depending on the location and anatomy of the teeth more precisely. The current study used only the Lava True Definition intraoral scanner; the results cannot be directly applied to other systems so there is a scope to repeat the same study with different scanning systems.

CHAPTER VI

CONCLUSIONS

Within the limitations of this study, the following conclusions have been drawn:

1. Buccal surfaces of mandibular first molar SICs and contralateral natural teeth were overcontoured in relation to the lingual surfaces.
2. Mandibular first molar SICs were undercontoured in relation to their contralateral natural teeth.
3. There was no correlation between mandibular first molar SICs emergence angles and PI.
4. There was no correlation between mandibular first molar SICs emergence angles and PD.
5. There were two correlations between the overcontoured emergence angle of ≤ 106 degrees emergence angle to BOP on the mesiobuccal and midbuccal surfaces of the mandibular first molar SICs.

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APPENDIX A

Emergence angle

Angle analysis in degree (0)

Pearson's correlation of angle measurements

		NLDistal	NLMid	NLMesial	NBDistal	NBMid	NBMesial	ILDistal	ILMid	ILMesial	IBDistal	IBMid	IBMesial
NBDistal	Pearson's Correlation	1	,900**	,803**	,591	,589	,356	,585	,406	,382	,404	,574	,696*
	Sig. (bilateral)		,000	,005	,072	,073	,313	,076	,244	,277	,247	,083	,025
	N	10	10	10	10	10	10	10	10	10	10	10	10
NBMid	Pearson's Correlation	,900**	1	,668*	,611	,716*	,389	,631	,659*	,629	,569	,774**	,810**
	Sig. (bilateral)	,000		,035	,060	,020	,267	,050	,038	,051	,086	,009	,005
	N	10	10	10	10	10	10	10	10	10	10	10	10
NBMesial	Pearson's Correlation	,803**	,668*	1	,435	,280	,365	,318	,032	,289	,321	,499	,420
	Sig. (bilateral)	,005	,035		,209	,433	,300	,371	,929	,418	,367	,142	,227
	N	10	10	10	10	10	10	10	10	10	10	10	10
NLDistal	Pearson's Correlation	,591	,611	,435	1	,620	,715*	,466	,299	,624	,766**	,728*	,819**
	Sig. (bilateral)	,072	,060	,209		,056	,020	,174	,402	,054	,010	,017	,004
	N	10	10	10	10	10	10	10	10	10	10	10	10
NLMid	Pearson's Correlation	,589	,716*	,280	,620	1	,765**	,221	,472	,364	,317	,658*	,764*
	Sig. (bilateral)	,073	,020	,433	,056		,010	,539	,169	,301	,373	,039	,010
	N	10	10	10	10	10	10	10	10	10	10	10	10
NLMesial	Pearson's Correlation	,356	,389	,365	,715*	,765**	1	-,008	,065	,292	,377	,645*	,642*
	Sig. (bilateral)	,313	,267	,300	,020	,010		,983	,858	,413	,283	,044	,045
	N	10	10	10	10	10	10	10	10	10	10	10	10
IBDistal	Pearson's Correlation	,585	,631	,318	,466	,221	-,008	1	,752*	,664*	,544	,452	,614
	Sig. (bilateral)	,076	,050	,371	,174	,539	,983		,012	,036	,104	,190	,059
	N	10	10	10	10	10	10	10	10	10	10	10	10
IBMid	Pearson's Correlation	,406	,659*	,032	,299	,472	,065	,752*	1	,749*	,548	,604	,678*
	Sig. (bilateral)	,244	,038	,929	,402	,169	,858	,012		,013	,101	,064	,031
	N	10	10	10	10	10	10	10	10	10	10	10	10
IBMesial	Pearson's Correlation	,382	,629	,289	,624	,364	,292	,664*	,749*	1	,873**	,789**	,715*
	Sig. (bilateral)	,277	,051	,418	,054	,301	,413	,036	,013		,001	,007	,020
	N	10	10	10	10	10	10	10	10	10	10	10	10
ILDistal	Pearson's Correlation	,404	,569	,321	,766**	,317	,377	,544	,548	,873**	1	,837**	,776**
	Sig. (bilateral)	,247	,086	,367	,010	,373	,283	,104	,101	,001		,003	,008
	N	10	10	10	10	10	10	10	10	10	10	10	10

ILMid	Pearson’s Correlation	,574	,774**	,499	,728*	,658*	,645*	,452	,604	,789**	,837**	1	,863**
	Sig. (bilateral)	,083	,009	,142	,017	,039	,044	,190	,064	,007	,003		,001
	N	10	10	10	10	10	10	10	10	10	10	10	10
ILMesial	Pearson’s Correlation	,696*	,810**	,420	,819**	,764*	,642*	,614	,678*	,715*	,776**	,863**	1
	Sig. (bilateral)	,025	,005	,227	,004	,010	,045	,059	,031	,020	,008	,001	
	N	10	10	10	10	10	10	10	10	10	10	10	10
**. Correlation is significant at the level 0,01 (bilateral).													
*. Correlation is significant at the level 0,05 (bilateral).													

Yellow color means the existence of correlation.
Green color means the lack of correlation.

Pearson’s correlation of angle subtractions

		NLMidvsDistal	NLMidvsMesial	NBMidvsDistal	NBMidvsMesial	ILMidvsDistal	ILMidvsMesial	IBMidvsDistal	IBMidvsMesial
NBMidvsDistal	Pearson’s Correlation	1	,815**	,375	,535	,414	,165	,274	,375
	Sig. (bilateral)		,004	,286	,111	,235	,649	,444	,285
	N	10	10	10	10	10	10	10	10
NBMidvsNBMesial	Pearson’s Correlation	,815**	1	,448	,810**	,282	,489	,202	-,077
	Sig. (bilateral)	,004		,194	,004	,430	,152	,577	,832
	N	10	10	10	10	10	10	10	10
NLMidvsDistal	Pearson’s Correlation	,375	,448	1	,623	,663*	,648*	,812**	-,053
	Sig. (bilateral)	,286	,194		,054	,037	,043	,004	,884
	N	10	10	10	10	10	10	10	10
NLMidvsMesial	Pearson’s Correlation	,535	,810**	,623	1	,316	,727*	,265	-,267
	Sig. (bilateral)	,111	,004	,054		,374	,017	,459	,455
	N	10	10	10	10	10	10	10	10
IBMidvsDistal	Pearson’s Correlation	,414	,282	,663*	,316	1	,300	,368	,280
	Sig. (bilateral)	,235	,430	,037	,374		,399	,295	,433
	N	10	10	10	10	10	10	10	10
IBMidvsMesial	Pearson’s Correlation	,165	,489	,648*	,727*	,300	1	,343	-,392
	Sig. (bilateral)	,649	,152	,043	,017	,399		,331	,262
	N	10	10	10	10	10	10	10	10
ILMidvsDistal	Pearson’s Correlation	,274	,202	,812**	,265	,368	,343	1	,285
	Sig. (bilateral)	,444	,577	,004	,459	,295	,331		,424
	N	10	10	10	10	10	10	10	10
ILMidvsMesial	Pearson’s Correlation	,375	-,077	-,053	-,267	,280	-,392	,285	1
	Sig. (bilateral)	,285	,832	,884	,455	,433	,262	,424	

	N	10	10	10	10	10	10	10	10
**. Correlation is significant at the level 0,01 (bilateral).									
*. Correlation is significant at the level 0,05 (bilateral).									

Yellow color means the existence of correlation.
Green color means the lack of correlation.

Plaque index

Relationship between plaque index and location of implant

ANOVA

		Sum of squares	gl	Half quadratic	F	Sig.
PI.NBMesial	Between groups	,017	1	,017	,084	,779
	Within groups	1,583	8	,198		
	Total	1,600	9			
PI.NBMid	Between groups	,150	1	,150	1,600	,242
	Within groups	,750	8	,094		
	Total	,900	9			
PI.NBDistal	Between groups	,017	1	,017	,084	,779
	Within groups	1,583	8	,198		
	Total	1,600	9			
PI.NLMesial	Between groups	,017	1	,017	,084	,779
	Within groups	1,583	8	,198		
	Total	1,600	9			
PI.NLMid	Between groups	,017	1	,017	,084	,779
	Within groups	1,583	8	,198		
	Total	1,600	9			
PI.NLDistal	Between groups	,017	1	,017	,084	,779
	Within groups	1,583	8	,198		
	Total	1,600	9			
PI.IBMesial	Between groups	,067	1	,067	,640	,447
	Within groups	,833	8	,104		
	Total	,900	9			
PI.IBMid	Between groups	,067	1	,067	,640	,447
	Within groups	,833	8	,104		
	Total	,900	9			
PI.IBDistal	Between groups	,000	1	,000	.	.
	Within groups	,000	8	,000		
	Total	,000	9			
PI.ILMesial	Between groups	,150	1	,150	1,600	,242
	Within groups	,750	8	,094		
	Total	,900	9			

PI.ILMid	Between groups	,017	1	,017	,084	,779
	Within groups	1,583	8	,198		
	Total	1,600	9			
PI.ILDistal	Between groups	,067	1	,067	,640	,447
	Within groups	,833	8	,104		
	Total	,900	9			

Relationship between plaque index and type of restoration

ANOVA

		Sum of squares	gl	Half quadratic	F	Sig.
PI.NBMesial	Between groups	,171	1	,171	,960	,356
	Within groups	1,429	8	,179		
	Total	1,600	9			
PI.NBMid	Between groups	,043	1	,043	,400	,545
	Within groups	,857	8	,107		
	Total	,900	9			
PI.NBDistal	Between groups	,171	1	,171	,960	,356
	Within groups	1,429	8	,179		
	Total	1,600	9			
PI.NLMesial	Between groups	,171	1	,171	,960	,356
	Within groups	1,429	8	,179		
	Total	1,600	9			
PI.NLMid	Between groups	,171	1	,171	,960	,356
	Within groups	1,429	8	,179		
	Total	1,600	9			
PI.NLDistal	Between groups	,171	1	,171	,960	,356
	Within groups	1,429	8	,179		
	Total	1,600	9			
PI.IBMesial	Between groups	,043	1	,043	,400	,545
	Within groups	,857	8	,107		
	Total	,900	9			
PI.IBMid	Between groups	,043	1	,043	,400	,545
	Within groups	,857	8	,107		
	Total	,900	9			
PI.IBDistal	Between groups	,000	1	,000	.	.
	Within groups	,000	8	,000		
	Total	,000	9			
PI.ILMesial	Between groups	,043	1	,043	,400	,545

	Within groups	,857	8	,107		
	Total	,900	9			
PI.ILMid	Between groups	,171	1	,171	,960	,356
	Within groups	1,429	8	,179		
	Total	1,600	9			
PI.ILDistal	Between groups	,043	1	,043	,400	,545
	Within groups	,857	8	,107		
	Total	,900	9			

Correlations between emergence angle & PI paired samples

		N	Correlation	Sig.
Pair 1	NLDistal & PI.NLDistal	10	-.468	.172
Pair 2	NLMid & PI.NLMid	10	-.007	.985
Pair 3	NLMesial & PI.NLMesial	10	-.377	.282
Pair 4	NBDistal & PI.NBDistal	10	-.116	.750
Pair 5	NBMid & PI.NBMid	10	-.146	.688
Pair 6	NBMesial & PI.NBMesial	10	-.346	.327
Pair 7	ILDistal & PI.ILDistal	10	-.001	.998
Pair 8	ILMid & PI.ILMid	10	.118	.746
Pair 9	ILMesial & PI.ILMesial	10	.333	.347
Pair 10	IBDistal & PI.IBDistal	10	.	.
Pair 11	IBMid & PI.IBMid	10	-.091	.803
Pair 12	IBMesial & PI.IBMesial	10	-.190	.600

Correlations between emergence angle & PI paired samples paired differences

		Paired differences				
					95% confidence interval of the diffe	
		Mean	Standard deviation	Standard error average	Inferior	Superior
Pair 1	NLDistal - PI.NLDistal	116.16800	18.61212	5.88567	102.85369	129.48231
Pair 2	NLMid - PI.NLMid	116.31300	24.08344	7.61585	99.08474	133.54126
Pair 3	NLMesial - PI.NLMesial	120.38700	15.53068	4.91123	109.27702	131.49698
Pair 4	NBDistal - PI.NBDistal	104.42900	19.60963	6.20111	90.40111	118.45689
Pair 5	NBMid - PI.NBMid	97.99800	24.35949	7.70315	80.57227	115.42373
Pair 6	NBMesial - PI.NBMesial	103.55800	22.01946	6.96316	87.80623	119.30977
Pair 7	ILDistal - PI.ILDistal	120.18900	23.76733	7.51589	103.18688	137.19112
Pair 8	ILMid - PI.ILMid	131.93100	21.15482	6.68974	116.79775	147.06425
Pair 9	ILMesial - PI.ILMesial	117.61800	18.62565	5.88995	104.29401	130.94199
Pair 10	IBDistal - PI.IBDistal	112.94800	25.77775	8.15164	94.50771	131.38829
Pair 11	IBMid - PI.IBMid	105.21400	25.45384	8.04921	87.00542	123.42258

Pair 12 IBMesial - PI.IBMesial	103.77500	22.79259	7.20765	87.47017	120.07983

Correlations between PI & BOP paired samples

Correlations of paired samples

		N	Correlation	Sig.
Pair 1	PI.NBDistal & BOP.NBDistal	10	-,408	,242
Pair 2	PI.NBMid & BOP.NBMid	10	-,167	,645
Pair 3	PI.NBMesial & BOP.NBMesial	10	,218	,545
Pair 4	PI.NLDistal & BOP.NLDistal	10	-,167	,645
Pair 5	PI.NLMid & BOP.NLMid	10	.	.
Pair 6	PI.NLMesial & BOP.NLMesial	10	-,167	,645
Pair 7	PI.IBDistal & BOP.IBDistal	10	.	.
Pair 8	PI.IBMid & BOP.IBMid	10	,667	,035
Pair 9	PI.IBMesial & BOP.IBMesial	10	,408	,242
Pair 10	PI.ILDistal & BOP.ILDistal	10	-,218	,545
Pair 11	PI.ILMid & BOP.ILMid	10	-,250	,486
Pair 12	PI.ILMesial & BOP.ILMesial	10	-,111	,760

Correlations between PI & BOP paired samples paired differences

Correlations of paired samples

		Paired differences							
					95% confidence interval of the difference				
		Mean	Standard deviation	Standard error average	Inferior	Superior	t	gl	Sig. (bilateral)
Pair 1	PI.NBDistal - BOP.NBDistal	,80000	,78881	,24944	,23572	1,36428	3,207	9	,011
Pair 2	PI.NBMid - BOP.NBMid	,90000	,56765	,17951	,49393	1,30607	5,014	9	,001
Pair 3	PI.NBMesial - BOP.NBMesial	,90000	,56765	,17951	,49393	1,30607	5,014	9	,001
Pair 4	PI.NLDistal - BOP.NLDistal	1,10000	,56765	,17951	,69393	1,50607	6,128	9	,000
Pair 5	PI.NLMid - BOP.NLMid	1,20000	,42164	,13333	,89838	1,50162	9,000	9	,000
Pair 6	PI.NLMesial - BOP.NLMesial	1,10000	,56765	,17951	,69393	1,50607	6,128	9	,000

Pair 7	PI.IBDistal - BOP.IBDistal	,80000	,42164	,13333	,49838	1,10162	6,000	9	,000
Pair 8	PI.IBMid - BOP.IBMid	,90000	,31623	,10000	,67378	1,12622	9,000	9	,000
Pair 9	PI.IBMesial - BOP.IBMesial	,70000	,48305	,15275	,35445	1,04555	4,583	9	,001
Pair 10	PI.ILDistal - BOP.ILDistal	,80000	,63246	,20000	,34757	1,25243	4,000	9	,003
Pair 11	PI.ILMid - BOP.ILMid	1,00000	,66667	,21082	,52310	1,47690	4,743	9	,001
Pair 12	PI.ILMesial - BOP.ILMesial	1,00000	,47140	,14907	,66278	1,33722	6,708	9	,000

Correlations between PI & PD paired samples

Correlations of paired samples

		N	Correlation	Sig.
Pair 1	PI.NBDistal & PD.NBDistal	10	-,102	,779
Pair 2	PI.NBMid & PD.NBMid	10	,677	,032
Pair 3	PI.NBMesial & PD.NBMesial	10	,401	,250
Pair 4	PI.NLDistal & PD.NLDistal	10	-,212	,557
Pair 5	PI.NLMid & PD.NLMid	10	,286	,424
Pair 6	PI.NLMesial & PD.NLMesial	10	-,053	,884
Pair 7	PI.IBDistal & PD.IBDistal	10	.	.
Pair 8	PI.IBMid & PD.IBMid	10	-,667	,035
Pair 9	PI.IBMesial & PD.IBMesial	10	-,394	,260
Pair 10	PI.ILDistal & PD.ILDistal	10	-,304	,393
Pair 11	PI.ILMid & PD.ILMid	10	-,234	,515
Pair 12	PI.ILMesial & PD.ILMesial	10	,000	1,000

Correlations between PI & PD paired samples paired differences

Correlations of paired samples

		Paired differences							
					95% confidence interval of the difference				
		Media	Standard deviation	Standard error average	Inferior	Superior	t	gl	Sig. (bilateral)
Pair 1	PI.NBDistal - PD.NBDistal	-1,40000	,69921	,22111	-1,90018	-,89982	-6,332	9	,000
Pair 2	PI.NBMid - PD.NBMid	-,60000	,51640	,16330	-,96941	-,23059	-3,674	9	,005

Pair 3	PI.NBMesial - PD.NBMesial	-1,60000	,84327	,26667	-2,20324	-,99676	-6,000	9	,000
Pair 4	PI.NLDistal - PD.NLDistal	-1,70000	1,15950	,36667	-2,52946	-,87054	-4,636	9	,001
Pair 5	PI.NLMid - PD.NLMid	-,90000	,73786	,23333	-1,42784	-,37216	-3,857	9	,004
Pair 6	PI.NLMesial - PD.NLMesial	-1,90000	1,10050	,34801	-2,68725	-1,11275	-5,460	9	,000
Pair 7	PI.IBDistal - PD.IBDistal	-1,60000	,51640	,16330	-1,96941	-1,23059	-9,798	9	,000
Pair 8	PI.IBMid - PD.IBMid	-1,70000	,67495	,21344	-2,18283	-1,21717	-7,965	9	,000
Pair 9	PI.IBMesial - PD.IBMesial	-2,20000	1,31656	,41633	-3,14181	-1,25819	-5,284	9	,001
Pair 10	PI.ILDistal - PD.ILDistal	-1,90000	1,28668	,40689	-2,82044	-,97956	-4,670	9	,001
Pair 11	PI.ILMid - PD.ILMid	-1,10000	,87560	,27689	-1,72636	-,47364	-3,973	9	,003
Pair 12	PI.ILMesial - PD.ILMesial	-1,90000	,87560	,27689	-2,52636	-1,27364	-6,862	9	,000

Probing depth

Relationship between probing depth and location of implant
ANOVA

		Sum of squares	gl	Half quadratic	F	Sig.
PD.NBMesial	Between groups	1,350	1	1,350	1,728	,225
	Within groups	6,250	8	,781		
	Total	7,600	9			
PD.NBMid	Between groups	2,017	1	2,017	7,744	,024
	Within groups	2,083	8	,260		
	Total	4,100	9			
PD.NBDistal	Between groups	,150	1	,150	,533	,486
	Within groups	2,250	8	,281		
	Total	2,400	9			
PD.NLMesial	Between groups	,150	1	,150	,137	,721
	Within groups	8,750	8	1,094		
	Total	8,900	9			
PD.NLMid	Between groups	1,067	1	1,067	2,226	,174
	Within groups	3,833	8	,479		
	Total	4,900	9			

PD.NLDistal	Between groups	,817	1	,817	,808	,395
	Within groups	8,083	8	1,010		
	Total	8,900	9			
PD.IBMesial	Between groups	,267	1	,267	,180	,682
	Within groups	11,833	8	1,479		
	Total	12,100	9			
PD.IBMid	Between groups	,017	1	,017	,084	,779
	Within groups	1,583	8	,198		
	Total	1,600	9			
PD.IBDistal	Between groups	,150	1	,150	,533	,486
	Within groups	2,250	8	,281		
	Total	2,400	9			
PD.ILMesial	Between groups	1,667	1	1,667	3,077	,117
	Within groups	4,333	8	,542		
	Total	6,000	9			
PD.ILMid	Between groups	,017	1	,017	,033	,861
	Within groups	4,083	8	,510		
	Total	4,100	9			
PD.ILDistal	Between groups	,417	1	,417	,288	,606
	Within groups	11,583	8	1,448		
	Total	12,000	9			

Relationship between probing depth and type of restoration

ANOVA

		Sum of squares	gl	Half quadratic	F	Sig.
PD.NBMesial	Between groups	,171	1	,171	,185	,679
	Within groups	7,429	8	,929		
	Total	7,600	9			
PD.NBMid	Between groups	,386	1	,386	,831	,389
	Within groups	3,714	8	,464		
	Total	4,100	9			
PD.NBDistal	Between groups	,019	1	,019	,064	,807
	Within groups	2,381	8	,298		
	Total	2,400	9			
PD.NLMesial	Between groups	1,376	1	1,376	1,463	,261
	Within groups	7,524	8	,940		
	Total	8,900	9			
PD.NLMid	Between groups	,043	1	,043	,071	,797
	Within groups	4,857	8	,607		
	Total	4,900	9			
PD.NLDistal	Between groups	,805	1	,805	,795	,399
	Within groups	8,095	8	1,012		
	Total	8,900	9			

PD.IBMesial	Between groups	,576	1	,576	,400	,545
	Within groups	11,524	8	1,440		
	Total	12,100	9			
PD.IBMid	Between groups	,171	1	,171	,960	,356
	Within groups	1,429	8	,179		
	Total	1,600	9			
PD.IBDistal	Between groups	,019	1	,019	,064	,807
	Within groups	2,381	8	,298		
	Total	2,400	9			
PD.ILMesial	Between groups	,476	1	,476	,690	,430
	Within groups	5,524	8	,690		
	Total	6,000	9			
PD.ILMid	Between groups	,005	1	,005	,009	,926
	Within groups	4,095	8	,512		
	Total	4,100	9			
PD.ILDistal	Between groups	1,905	1	1,905	1,509	,254
	Within groups	10,095	8	1,262		
	Total	12,000	9			

Correlations between emergence angle & PD paired samples

		N	Correlation	Sig.
Pair 1	NLDistal & PD.NLDistal	10	.263	.463
Pair 2	NLMid & PD.NLMid	10	.199	.581
Pair 3	NLMesial & PD.NLMesial	10	.474	.167
Pair 4	NBDistal & PD.NBDistal	10	-.476	.165
Pair 5	NBMid & PD.NBMid	10	-.315	.375
Pair 6	NBMesial & PD.NBMesial	10	-.255	.478
Pair 7	ILDistal & PD.ILDistal	10	-.492	.149
Pair 8	ILMid & PD.ILMid	10	-.197	.585
Pair 9	ILMesial & PD.ILMesial	10	-.137	.705
Pair 10	IBDistal & PD.IBDistal	10	.110	.762
Pair 11	IBMid & PD.IBMid	10	-.048	.895
Pair 12	IBMesial & PD.IBMesial	10	-.320	.368

Correlations between emergence angle & PD paired samples paired differences

		Paired differences				
					95% confidence Interval of the diff	
		Mean	Standard deviation	Standard error average	Inferior	Superior
Pair 1	NLDistal - PD.NLDistal	114.46800	18.17492	5.74741	101.46644	127.46956
Pair 2	NLMid - PD.NLMid	115.41300	23.94086	7.57076	98.28674	132.53926

Pair 3	NLMesial - PD.NLMesial	118.48700	14.92144	4.71857	107.81285	129.16115
Pair 4	NBDistal - PD.NBDistal	103.02900	19.80721	6.26359	88.85977	117.19823
Pair 5	NBMid - PD.NBMid	97.39800	24.53229	7.75779	79.84866	114.94734
Pair 6	NBMesial - PD.NBMesial	101.95800	22.12169	6.99549	86.13309	117.78291
Pair 7	ILDistal - PD.ILDistal	118.28900	24.35340	7.70122	100.86763	135.71037
Pair 8	ILMid - PD.ILMid	130.83100	21.34370	6.74947	115.56264	146.09936
Pair 9	ILMesial - PD.ILMesial	115.71800	18.85800	5.96342	102.22780	129.20820
Pair 10	IBDistal - PD.IBDistal	111.34800	25.72596	8.13526	92.94476	129.75124
Pair 11	IBMid - PD.IBMid	103.51400	25.44693	8.04703	85.31036	121.71764
Pair 12	IBMesial - PD.IBMesial	101.57500	23.12728	7.31349	85.03074	118.11926

Correlations between PI & BOP paired samples

Correlations of paired samples

		N	Correlation	Sig.
Pair 1	BOP.NBDistal & PD.NBDistal	10	,250	,486
Pair 2	BOP.NBMid & PD.NBMid	10	,234	,515
Pair 3	BOP.NBMesial & PD.NBMesial	10	-,100	,783
Pair 4	BOP.NLDistal & PD.NLDistal	10	,742	,014
Pair 5	BOP.NLMid & PD.NLMid	10	.	.
Pair 6	BOP.NLMesial & PD.NLMesial	10	,318	,371
Pair 7	BOP.IBDistal & PD.IBDistal	10	-,102	,779
Pair 8	BOP.IBMid & PD.IBMid	10	-,375	,286
Pair 9	BOP.IBMesial & PD.IBMesial	10	,148	,682
Pair 10	BOP.ILDistal & PD.ILDistal	10	,797	,006
Pair 11	BOP.ILMid & PD.ILMid	10	,156	,667
Pair 12	BOP.ILMesial & PD.ILMesial	10	,861	,001

Correlations between PI & BOP paired samples paired differences

Correlations of paired samples

		Paired differences							
					95% confidence interval of the difference				
		Mean	Standard deviation	Standard error average	Inferior	Superior	t	gl	Sig. (bilateral)
Pair 1	BOP.NBDistal - PD.NBDistal	-2,20000	,63246	,20000	-2,65243	-1,74757	-11,000	9	,000
Pair 2	BOP.NBMid - PD.NBMid	-1,50000	,70711	,22361	-2,00583	-,99417	-6,708	9	,000
Pair 3	BOP.NBMesial - PD.NBMesial	-2,50000	1,08012	,34157	-3,27267	-1,72733	-7,319	9	,000
Pair 4	BOP.NLDistal - PD.NLDistal	-2,80000	,78881	,24944	-3,36428	-2,23572	-11,225	9	,000

Pair 5	BOP.NLMid - PD.NLMid	-2,10000	,73786	,23333	-2,62784	-1,57216	-9,000	9	,000
Pair 6	BOP.NLMesial - PD.NLMesial	-3,00000	,94281	,29814	-3,67444	-2,32556	-10,062	9	,000
Pair 7	BOP.IBDistal - PD.IBDistal	-2,40000	,69921	,22111	-2,90018	-1,89982	-10,854	9	,000
Pair 8	BOP.IBMid - PD.IBMid	-2,60000	,69921	,22111	-3,10018	-2,09982	-11,759	9	,000
Pair 9	BOP.IBMesial - PD.IBMesial	-2,90000	1,19722	,37859	-3,75644	-2,04356	-7,660	9	,000
Pair 10	BOP.ILDistal - PD.ILDistal	-2,70000	,82327	,26034	-3,28893	-2,11107	-10,371	9	,000
Pair 11	BOP.ILMid - PD.ILMid	-2,10000	,73786	,23333	-2,62784	-1,57216	-9,000	9	,000
Pair 12	BOP.ILMesial - PD.ILMesial	-2,90000	,56765	,17951	-3,30607	-2,49393	-16,155	9	,000

Bleeding on Probing

Relationship between bleeding on probing and location of implant
ANOVA

		Sum of squares	gl	Half quadratic	F	Sig.
BOP.NBMesial	Between groups	,017	1	,017	,064	,807
	Within groups	2,083	8	,260		
	Total	2,100	9			
BOP.NBMid	Between groups	,017	1	,017	,084	,779
	Within groups	1,583	8	,198		
	Total	1,600	9			
BOP.NBDistal	Between groups	,067	1	,067	,229	,645
	Within groups	2,333	8	,292		
	Total	2,400	9			
BOP.NLMesial	Between groups	,150	1	,150	1,600	,242
	Within groups	,750	8	,094		
	Total	,900	9			
BOP.NLMid	Between groups	,000	1	,000	.	.
	Within groups	,000	8	,000		
	Total	,000	9			
BOP.NLDistal	Between groups	,150	1	,150	1,600	,242
	Within groups	,750	8	,094		
	Total	,900	9			
BOP.IBMesial	Between groups	,150	1	,150	,533	,486
	Within groups	2,250	8	,281		
	Total	2,400	9			
BOP.IBMid	Between groups	,017	1	,017	,084	,779
	Within groups	1,583	8	,198		
	Total	1,600	9			

BOP.IBDistal	Between groups	,017	1	,017	,084	,779
	Within groups	1,583	8	,198		
	Total	1,600	9			
BOP.ILMesial	Between groups	,150	1	,150	1,600	,242
	Within groups	,750	8	,094		
	Total	,900	9			
BOP.ILMid	Between groups	,600	1	,600	4,800	,060
	Within groups	1,000	8	,125		
	Total	1,600	9			
BOP.ILDistal	Between groups	,267	1	,267	1,164	,312
	Within groups	1,833	8	,229		
	Total	2,100	9			

Relationship between BOP and type of restoration

ANOVA

		Sum of squares	gl	Half quadratic	F	Sig.
BOP.NBMesial	Between groups	,005	1	,005	,018	,896
	Within groups	2,095	8	,262		
	Total	2,100	9			
BOP.NBMid	Between groups	,076	1	,076	,400	,545
	Within groups	1,524	8	,190		
	Total	1,600	9			
BOP.NBDistal	Between groups	,305	1	,305	1,164	,312
	Within groups	2,095	8	,262		
	Total	2,400	9			
BOP.NLMesial	Between groups	,043	1	,043	,400	,545
	Within groups	,857	8	,107		
	Total	,900	9			
BOP.NLMid	Between groups	,000	1	,000	.	.
	Within groups	,000	8	,000		
	Total	,000	9			
BOP.NLDistal	Between groups	,043	1	,043	,400	,545
	Within groups	,857	8	,107		
	Total	,900	9			
BOP.IBMesial	Between groups	,686	1	,686	3,200	,111
	Within groups	1,714	8	,214		
	Total	2,400	9			
BOP.IBMid	Between groups	,171	1	,171	,960	,356
	Within groups	1,429	8	,179		
	Total	1,600	9			
BOP.IBDistal	Between groups	,171	1	,171	,960	,356
	Within groups	1,429	8	,179		
	Total	1,600	9			

BOP.ILMesial	Between groups	,233	1	,233	2,800	,133
	Within groups	,667	8	,083		
	Total	,900	9			
BOP.ILMid	Between groups	,076	1	,076	,400	,545
	Within groups	1,524	8	,190		
	Total	1,600	9			
BOP.ILDistal	Between groups	,005	1	,005	,018	,896
	Within groups	2,095	8	,262		
	Total	2,100	9			

Correlations between emergence angle & BOP paired samples

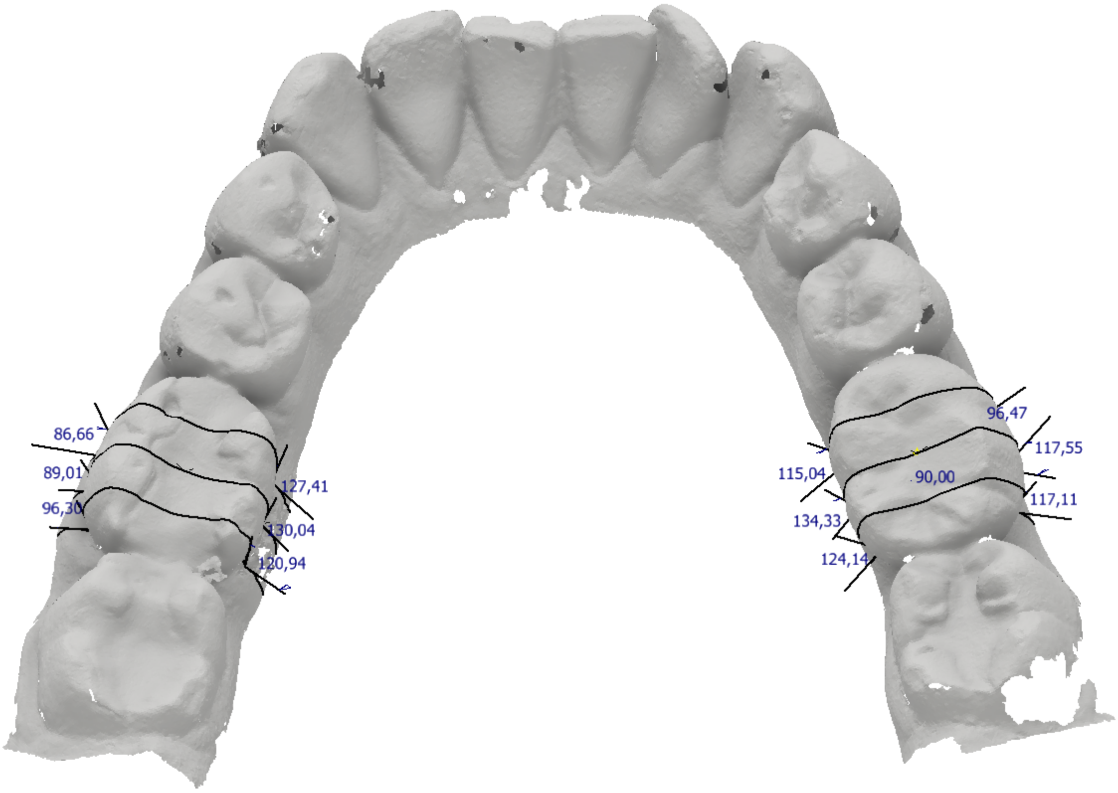
		N	Correlation	Sig.
Pair 1	NLDistal & BOP.NLDistal	10	-.049	.893
Pair 2	NLMid & BOP.NLMid	10	.	.
Pair 3	NLMesial & BOP.NLMesial	10	.086	.814
Pair 4	NBDistal & BOP.NBDistal	10	-.210	.560
Pair 5	NBMid & BOP.NBMid	10	.038	.916
Pair 6	NBMesial & BOP.NBMesial	10	.116	.751
Pair 7	ILDistal & BOP.ILDistal	10	-.319	.369
Pair 8	ILMid & BOP.ILMid	10	.090	.806
Pair 9	ILMesial & BOP.ILMesial	10	-.281	.432
Pair 10	IBDistal & BOP.IBDistal	10	.279	.435
Pair 11	IBMid & BOP.IBMid	10	-.686	.029
Pair 12	IBMesial & BOP.IBMesial	10	-.872	.001

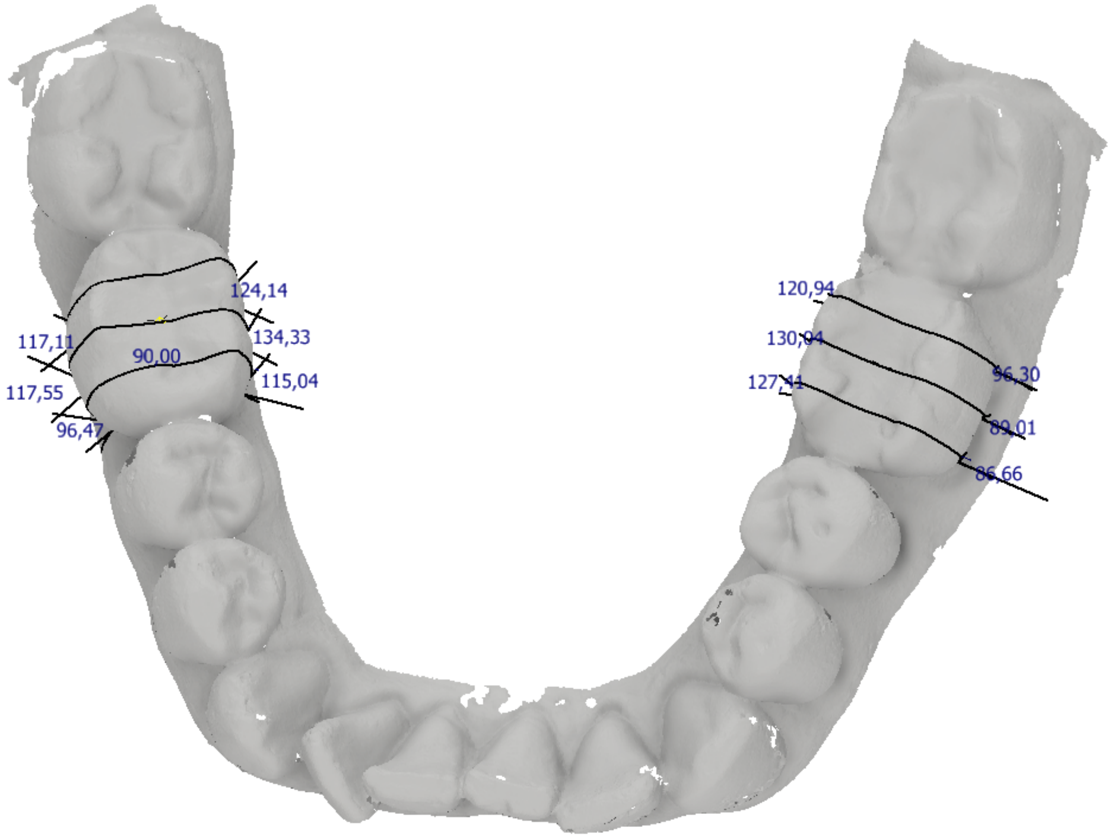
Correlations between emergence angle & BOP paired samples paired differences

		Paired differences				
					95% confidence interval of the di	
		Mean	Standard deviation	Standard error average	Inferior	Superior
Pair 1	NLDistal - BOP.NLDistal	117.26800	18.42915	5.82781	104.08458	130.45142
Pair 2	NLMid - BOP.NLMid	117.51300	24.07695	7.61380	100.28939	134.73661
Pair 3	NLMesial - BOP.NLMesial	121.48700	15.34284	4.85183	110.51140	132.46260
Pair 4	NBDistal - BOP.NBDistal	105.22900	19.67146	6.22066	91.15689	119.30111
Pair 5	NBMid - BOP.NBMid	98.89800	24.29888	7.68398	81.51563	116.28037
Pair 6	NBMesial - BOP.NBMesial	104.45800	21.81932	6.89987	88.84940	120.06660
Pair 7	ILDistal - BOP.ILDistal	120.98900	24.09870	7.62068	103.74983	138.22817
Pair 8	ILMid - BOP.ILMid	132.93100	21.56916	6.82077	117.50135	148.36065
Pair 9	ILMesial - BOP.ILMesial	118.61800	18.83175	5.95512	105.14658	132.08942
Pair 10	IBDistal - BOP.IBDistal	113.74800	25.66325	8.11543	95.38962	132.10638
Pair 11	IBMid - BOP.IBMid	106.11400	25.38882	8.02865	87.95193	124.27607
Pair 12	IBMesial - BOP.IBMesial	104.47500	22.88082	7.23555	88.10705	120.84295

Patients scans

Patient 1

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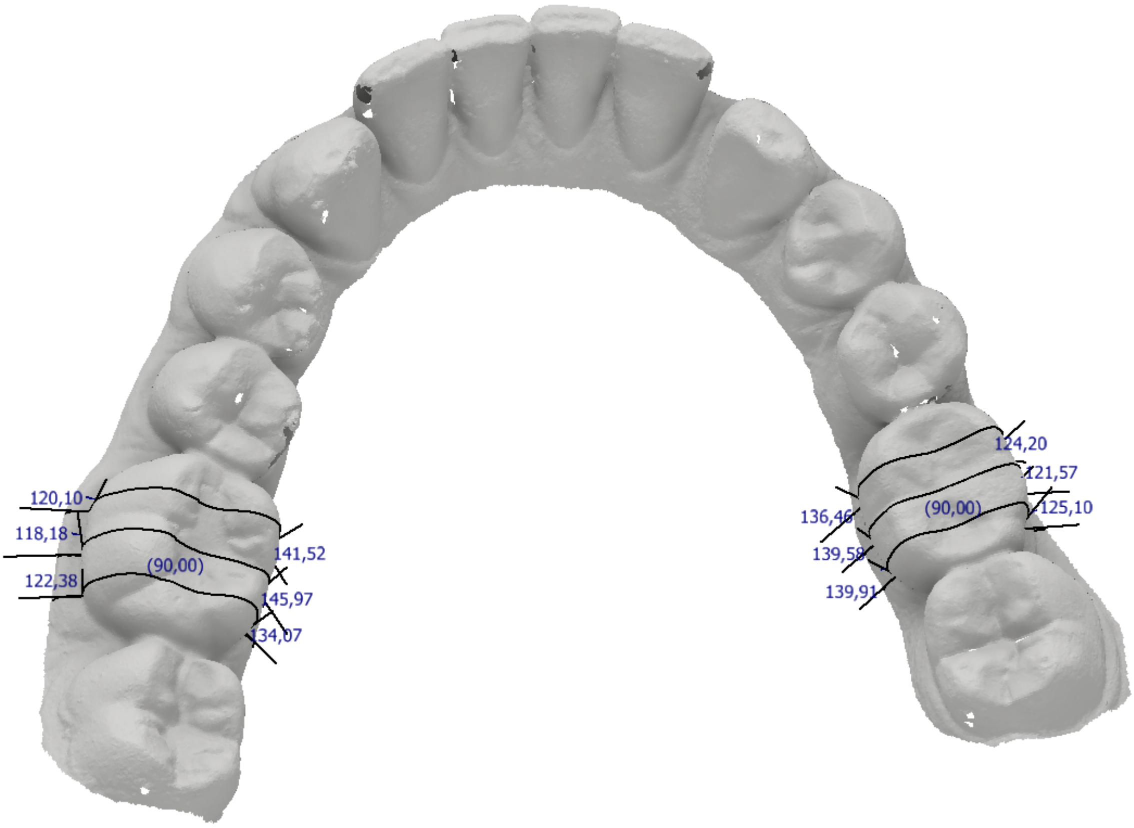
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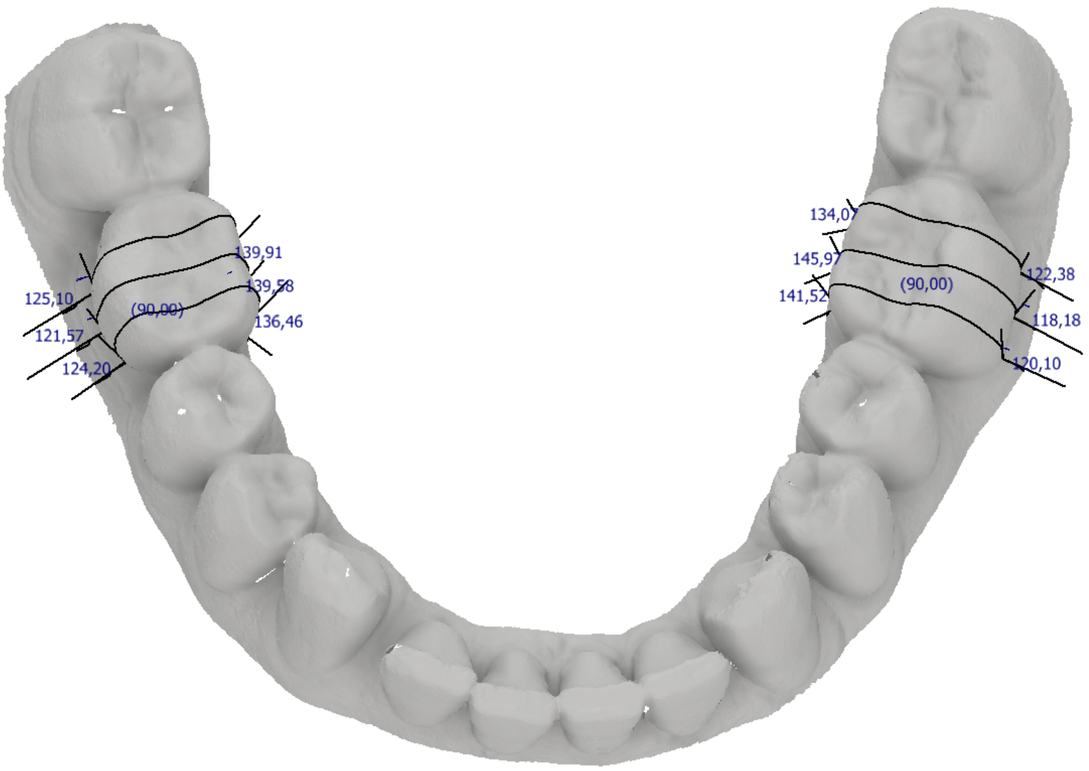

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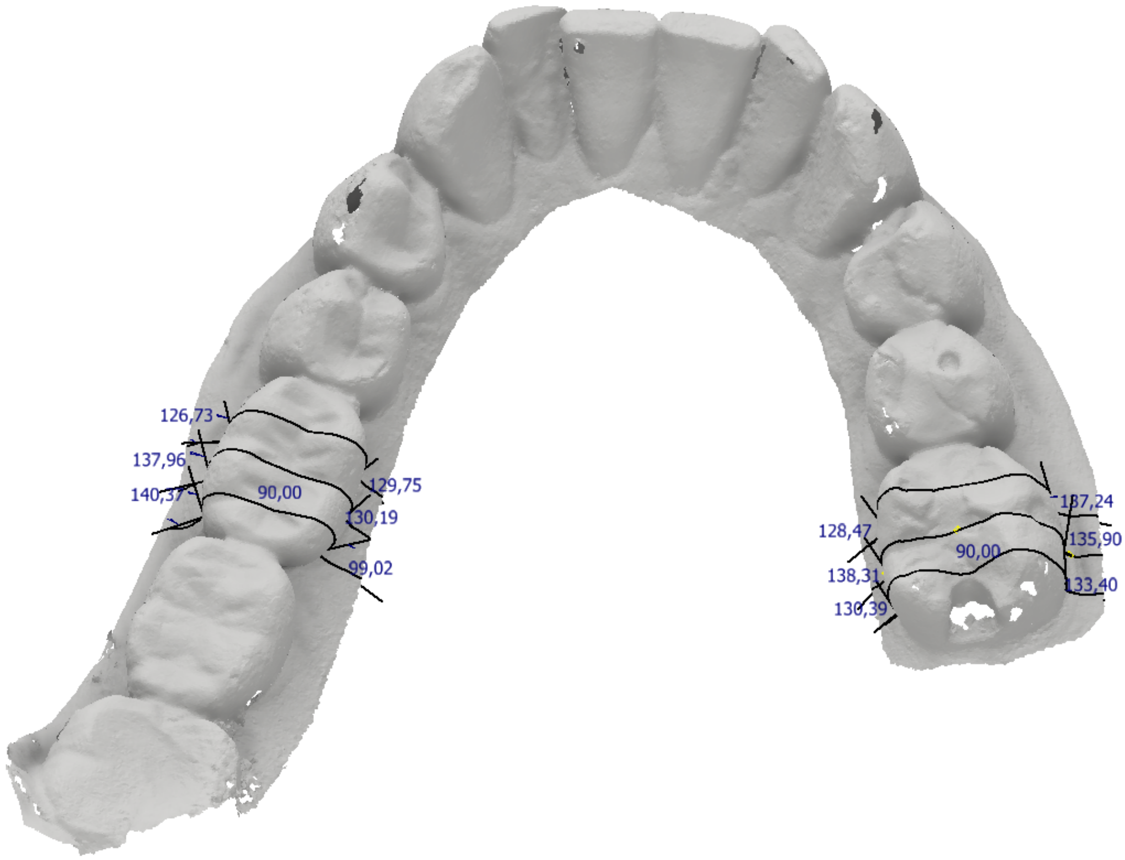

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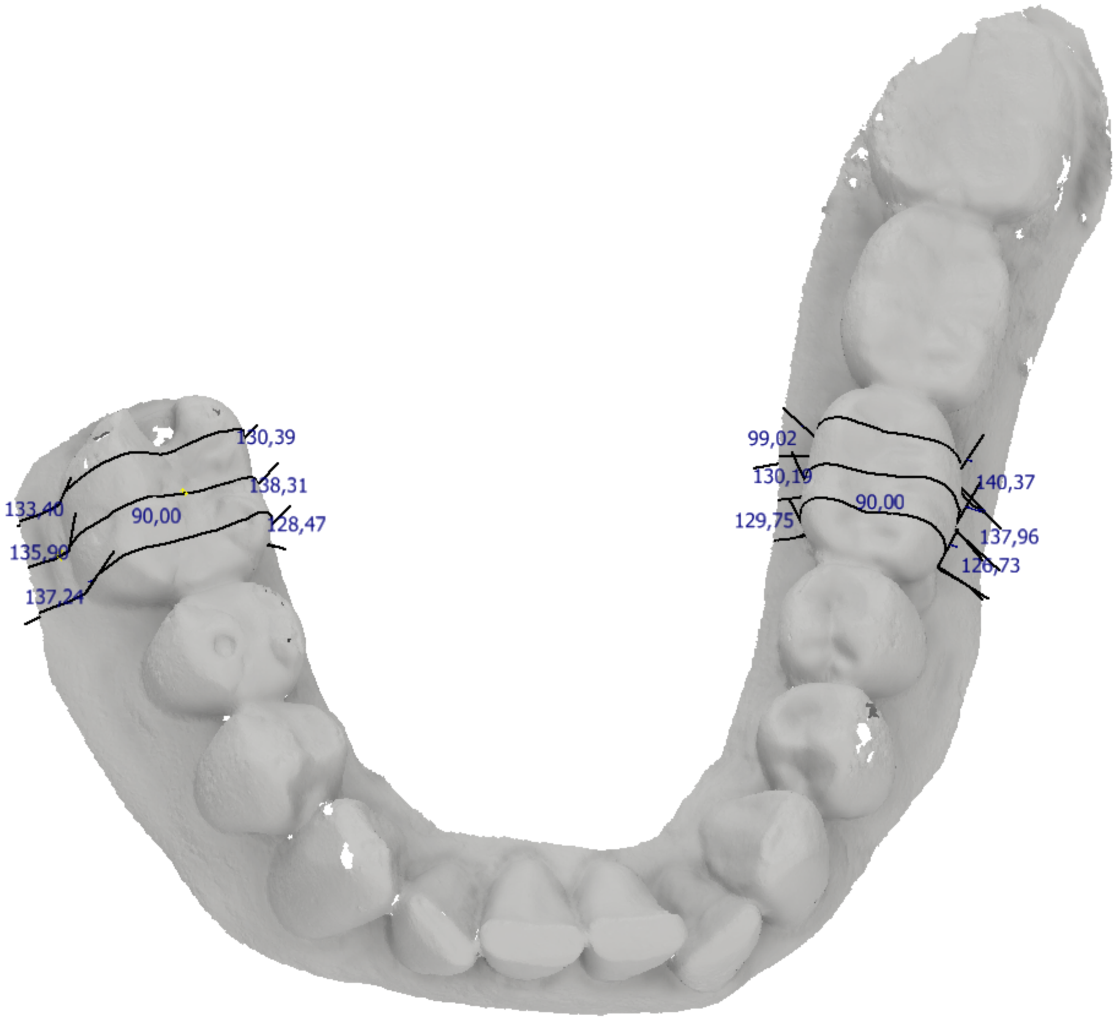
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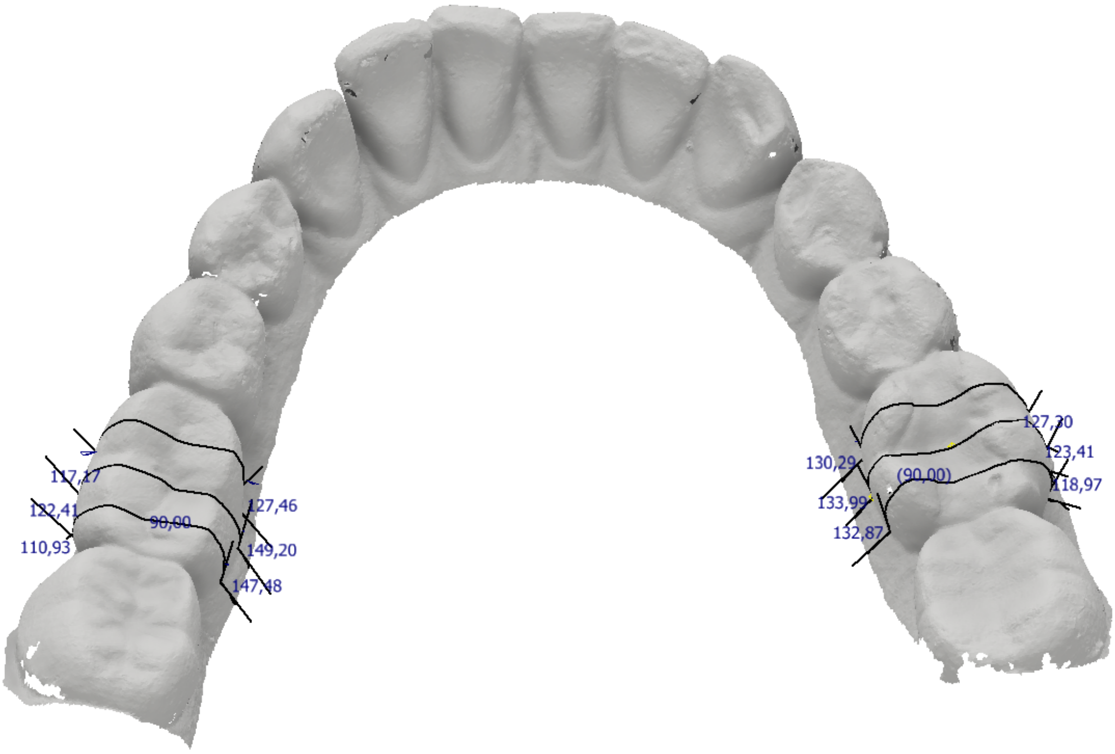
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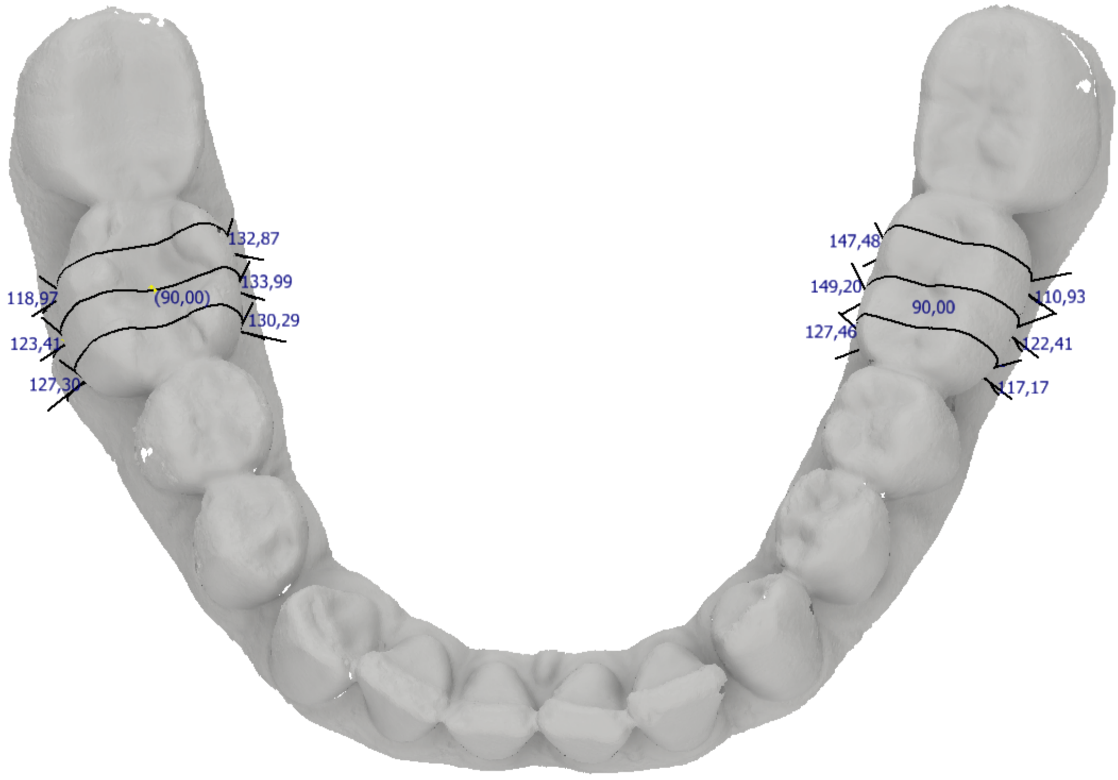
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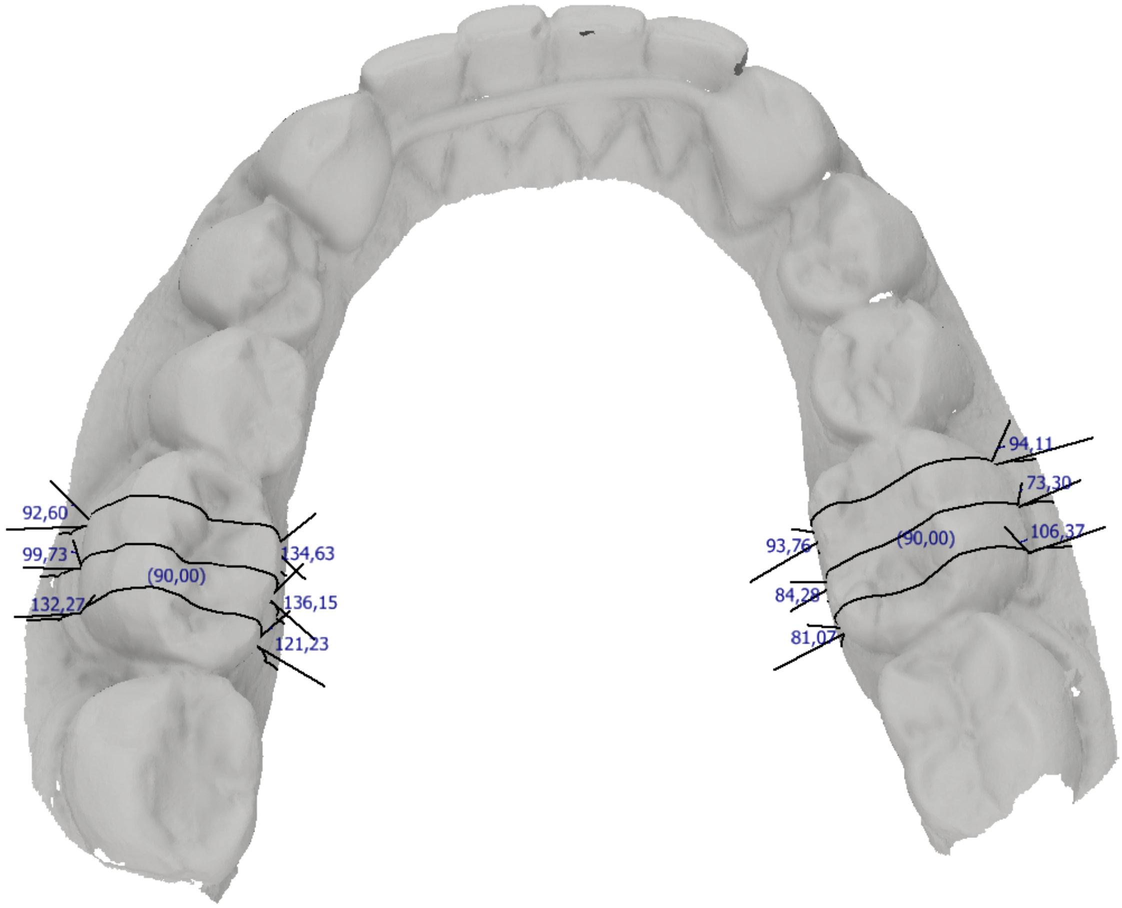
Patient 5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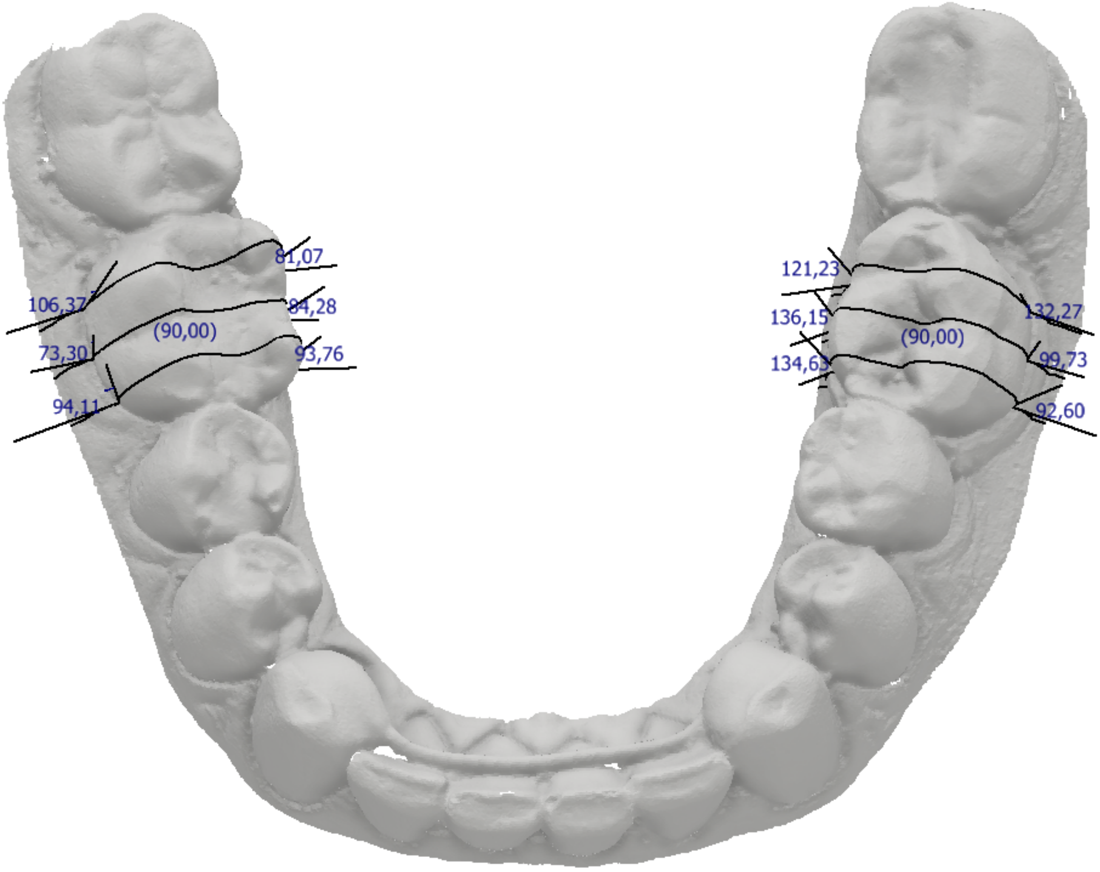
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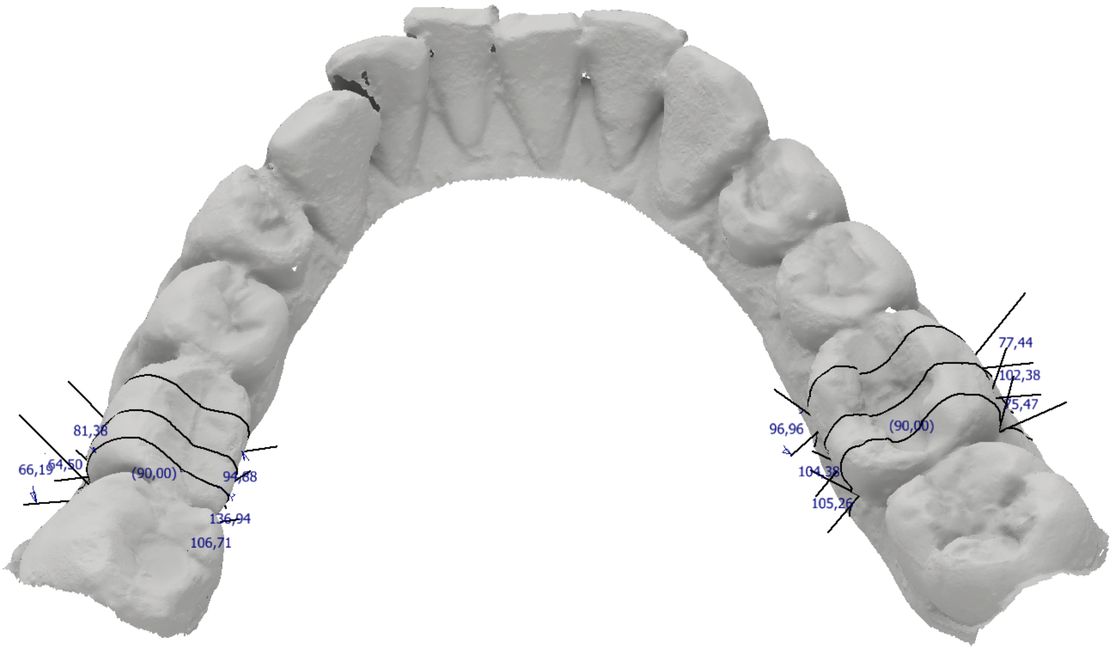
Patient 6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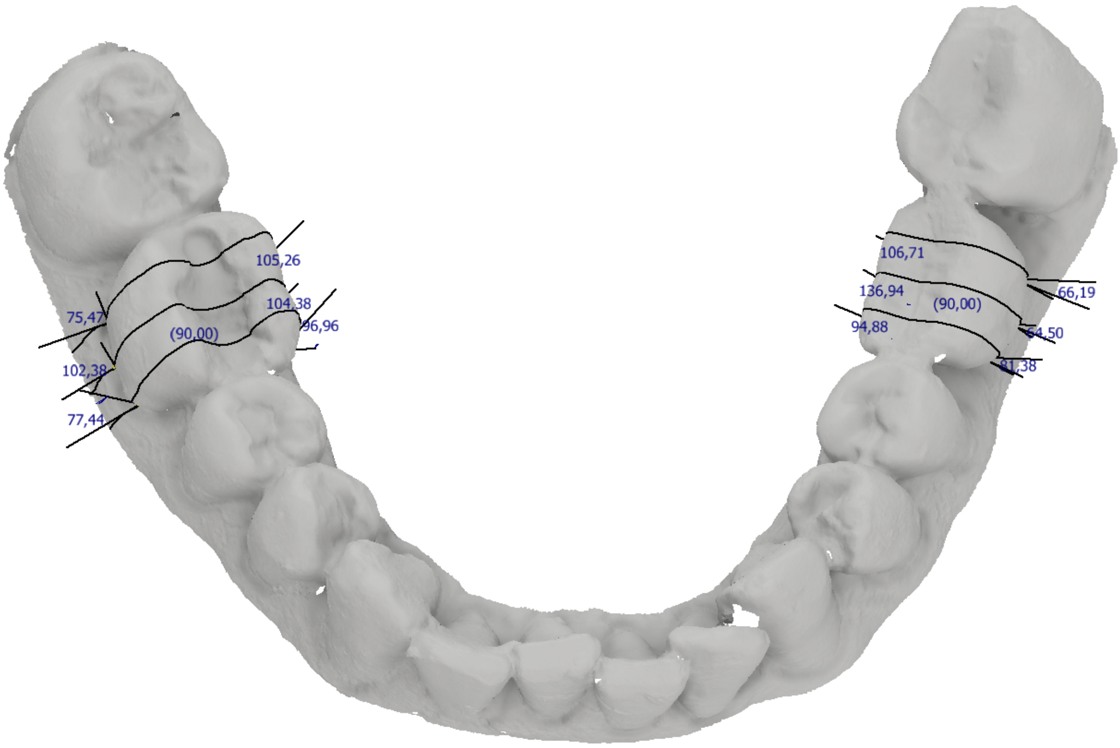
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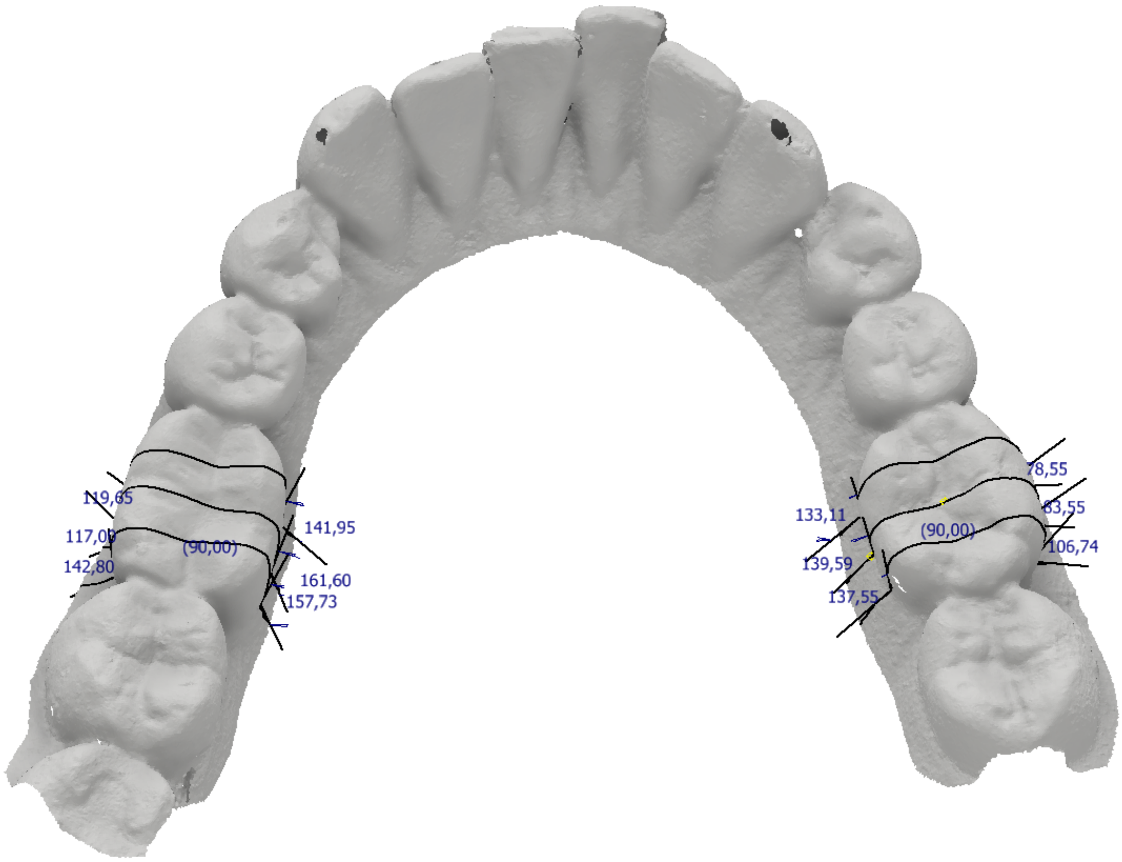
Patient 7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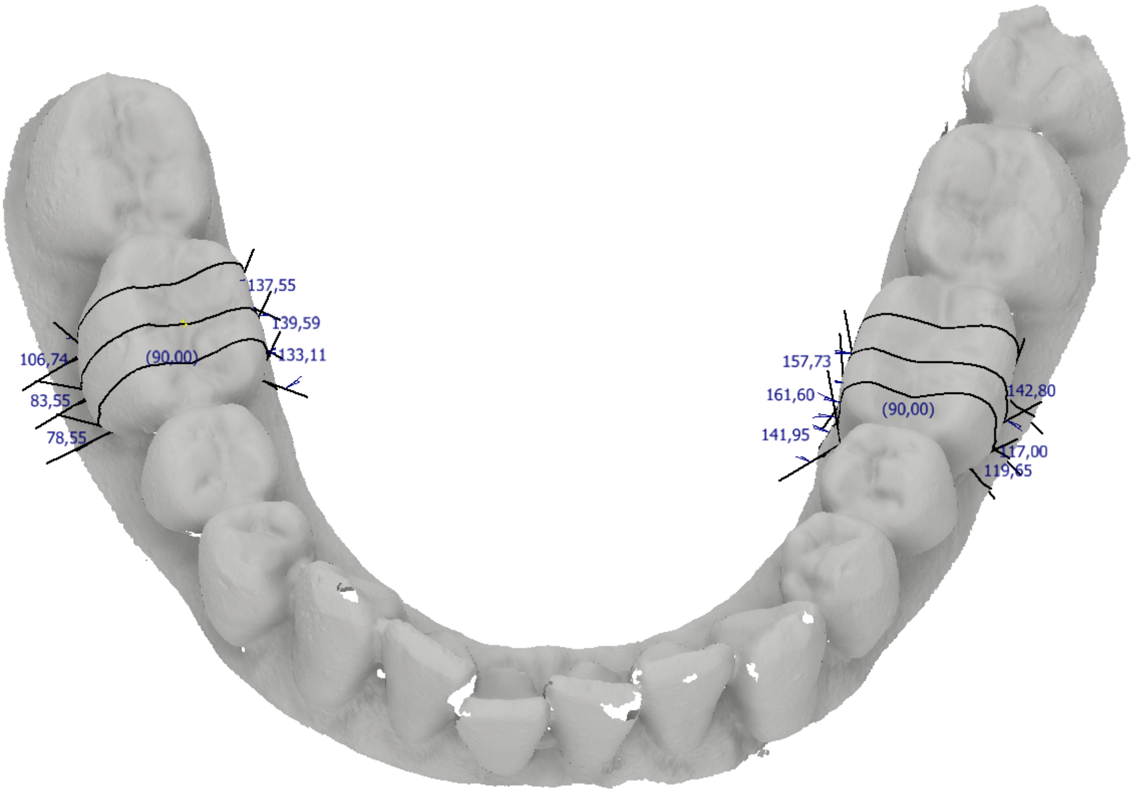
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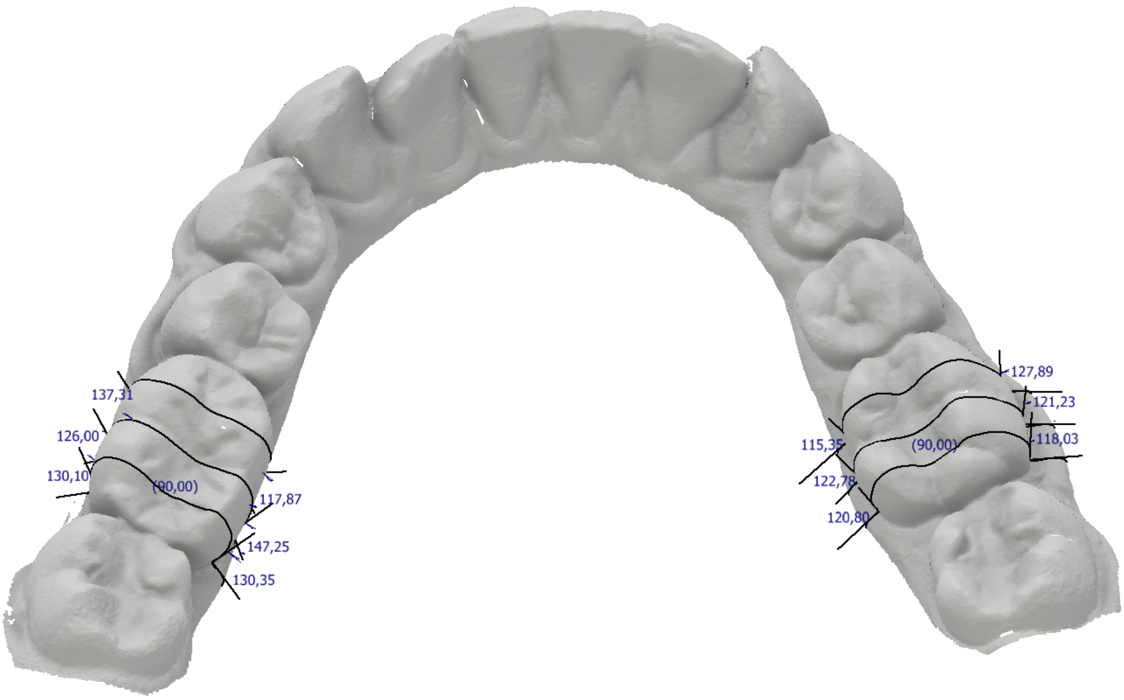
Patient 8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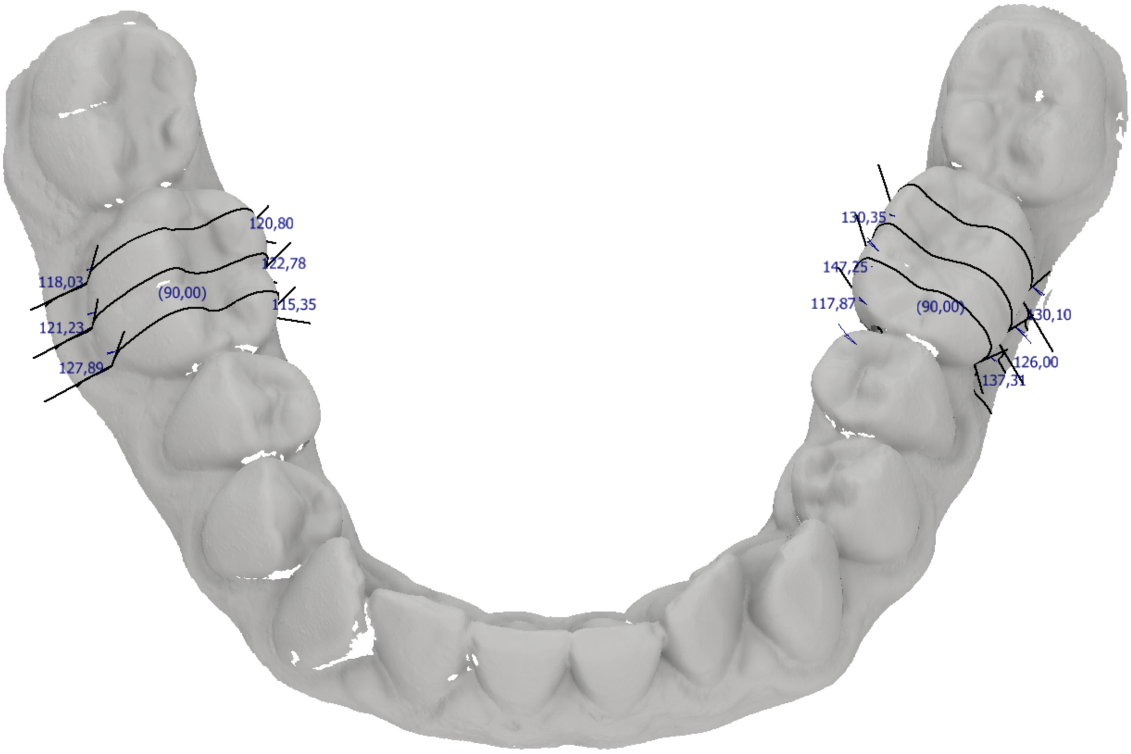
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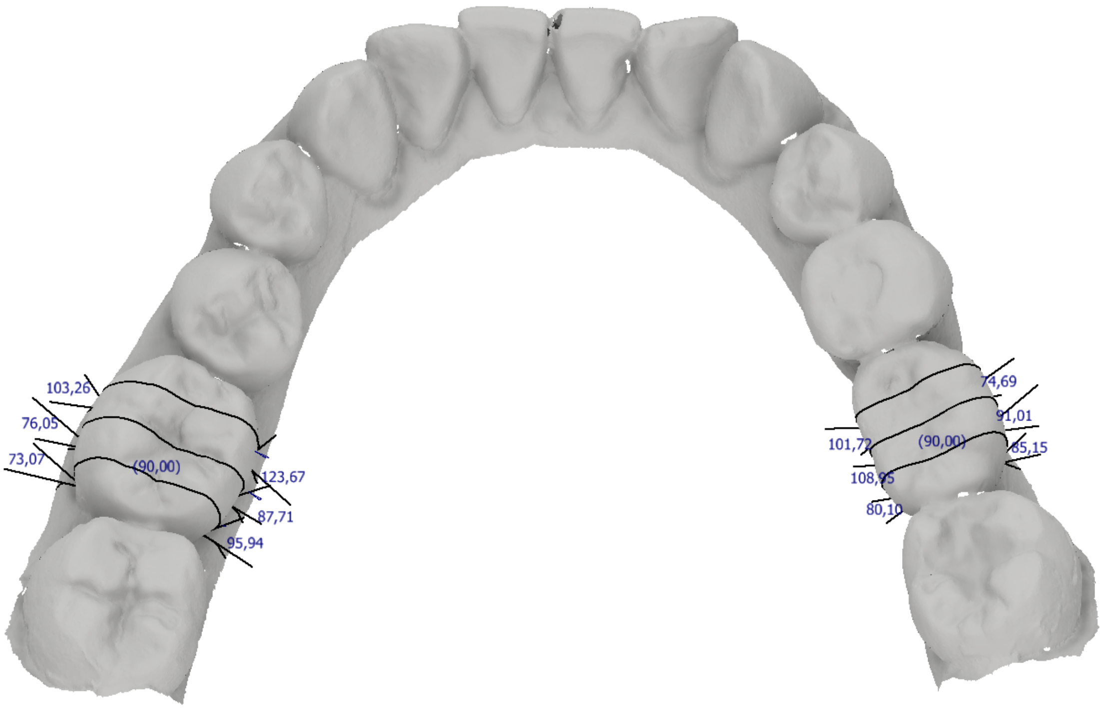
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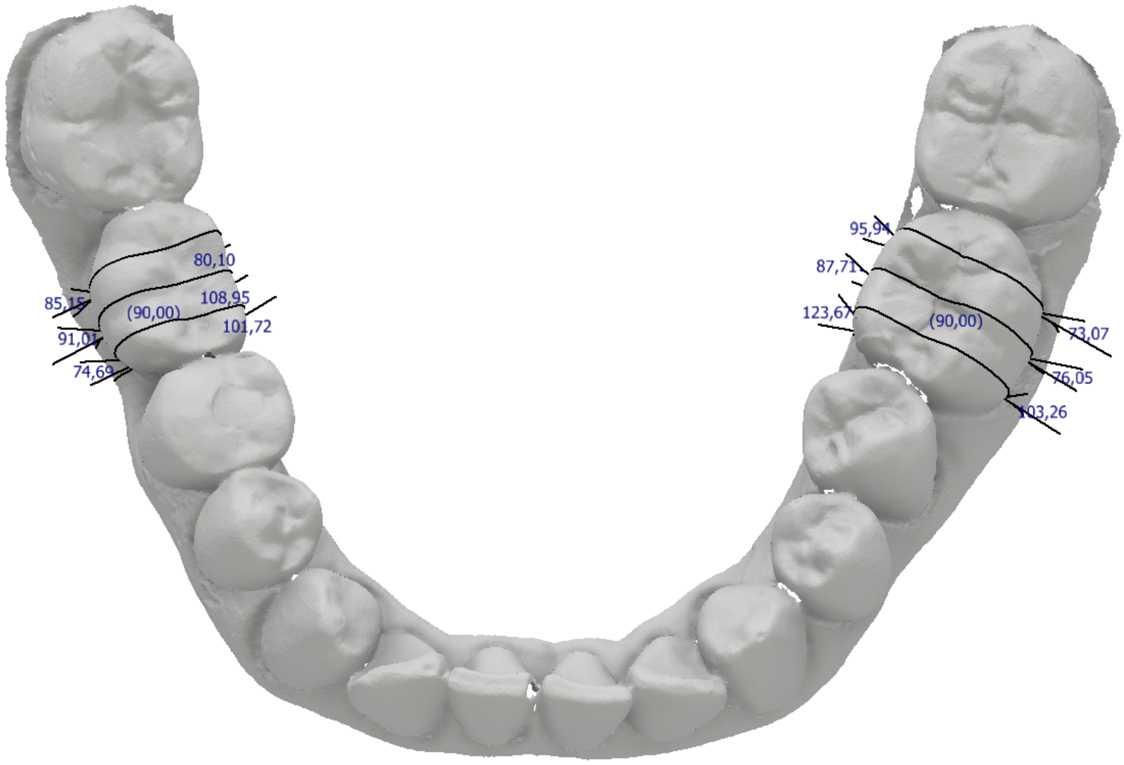
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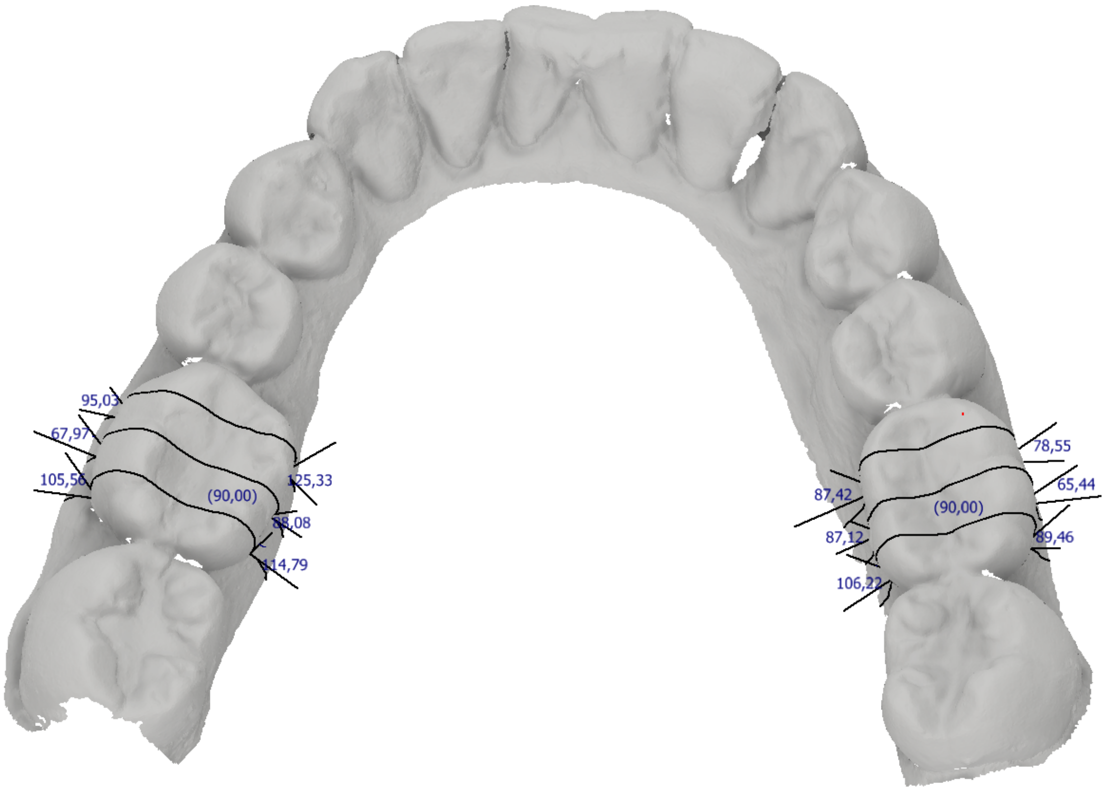
Patient 10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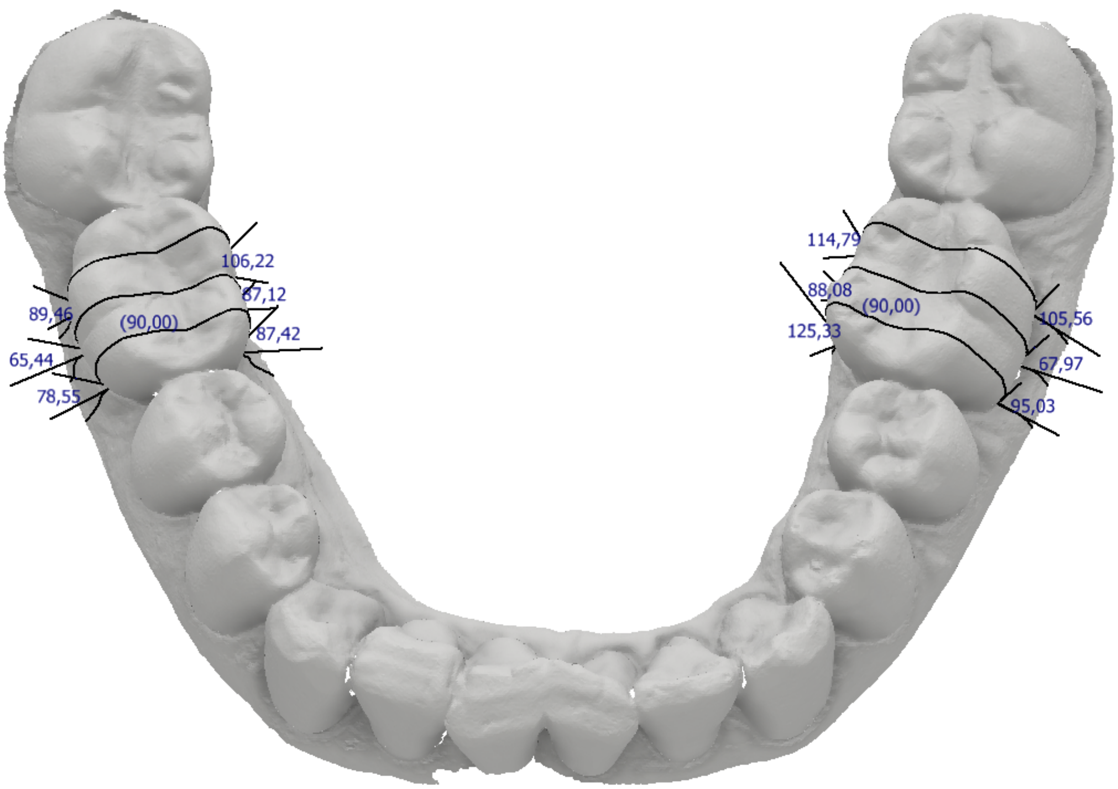
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